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Vol. XXVII. Part IV. DECEMBER, 1956.

THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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Page 139, line 23, *for* Mr. Hodgson *read* Mr. Hudgson

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THE TEA QUARTERLY

VOLUME XXVII. DECEMBER, 1956 PART IV.

SYMPOSIUM ON SHOT HOLE BORER

A Symposium on the shot hole borer pest of tea was held at the Ratnapura Club, Ratnapura, on the 14th September, 1956. The Symposium, which was arranged by the Sabaragamuwa Planters' Association in conjunction with the Tea Research Institute of Ceylon, was intended to cover every aspect of the problem. In particular it was hoped that, by providing a forum where the technical views of research officers and the experiences of practical planters could be freely exchanged, new ideas would emerge which might ultimately be put to use in combatting this very serious pest of tea at mid and low elevations.

Owing to limited accommodation attendance had perforce to be by invitation only but special care was taken to ensure that all those interests in any way connected with the problem were adequately represented. In addition to specialist officers of the Tea Research Institute those present included representatives of the various District Planters' Associations and of Agency Houses interested in shot hole borer, as well as technical representatives from those commercial firms concerned with crop protection and the supply of fertilisers. In addition a very welcome scientific visitor from overseas was Mr. S. Ananda Rau, the Entomologist of the United Planters' Association of South India, while the Department of Agriculture was represented by Dr. W. R. C. Paul, Acting Director of Agriculture. Other very welcome visitors were the Chairmen of the Planters' Association of Ceylon, Senator T. Amarasuriya, O.B.E., of the Agency Section, Mr. R. M. Macintyre, of the Low Country Products Association, Senator E. W. Kannangara, C.B.E., and of the Board of Control of the Tea Research Institute, Mr. F. Amarasuriya.

Finally the importance of the shot hole borer problem in relation to Ceylon's tea industry was underlined by the presence of the Hon'ble Minister of Agriculture and Food, Mr. D. P. R. Gunawardena, who had kindly consented to officially open the proceedings. The Minister's presence at the Symposium was especially welcome as it was the first occasion on which he had attended a meeting organised by a Planters' Association.

All the addresses and discussions were recorded and these, together with the various technical papers, are given in full in the succeeding pages. Having studied these carefully it is earnestly hoped that anyone who has anything further to contribute which might in any way assist in solving the shot hole borer problem will not hesitate to get in touch with the Tea Research Institute. The problem is indeed a difficult one and requires the co-operation of all who have the interests of Ceylon's tea industry at heart.

OPENING ADDRESS BY D. L. COWLING, ESQ., CHAIRMAN, SABARAGAMUWA PLANTERS' ASSOCIATION

It gives me much pleasure to welcome our many distinguished guests and the Hon'ble Minister for Agriculture and Food—Mr. Philip Gunawardena in particular. He has very kindly agreed to address us during the proceedings, and I am sure you will all look forward to hearing what he has to say.

This is the first official visit the Minister has made to a gathering of tea planters, and as such we must feel both honoured and privileged. The gesture is indicative of the keen interest the Minister, and his Ministry, are taking in the tea industry and the problems with which it is faced. I am also pleased to note that many others in high places have been good enough to grace us with their presence, and on behalf of the Sabaragamuwa Planters' Association, I extend to you all a most cordial welcome.

I should like to welcome the delegate from our sister organisation across the Palk Strait—Mr. Ananda Rau. Mr. Ananda Rau is the Entomologist of the United Planters' Association of Southern India. As you are aware the subject of this symposium is purely entomological and Mr. Ananda Rau, I hope, will later be giving us his views on the problem of shot-hole borer in South India. It is also very pleasing for me to extend a warm welcome to Dr. W. R. C. Paul, Director of Agriculture; Senator E. W. Kannangara, Chairman of the Low Country Products Association; Mr. R. M. Macintyre, Chairman of the Agency Section of the Planters' Association, and Mr. G. B. Portsmouth, Director of the Tea Research Institute of Ceylon, and his officers, without whom of course this symposium could not have been held.

I much regret that neither the Tea Controller nor the Government Entomologist were able to attend this conference. In particular it would have been of great interest to us to have heard the Government Entomologist's contribution towards the elucidation of the problem which we shall be discussing today, and especially his interpretation of the practicability, or otherwise, of chemical control.

It was only a little over a year ago that my predecessor in office, Mr. Savill, speaking from the chair in this room, proposed that our Association should make arrangements to hold a symposium, to which all District Planters' Associations should be invited, together with officers of the Tea Research Institute and other scientific representatives from the various interested firms and agency houses in Colombo, in order to discuss as fully as possible the very serious problem of *Xyleborus fornicatus*, or in other words shot-hole borer.

These proposals were prompted by the fact that for some years past the ravages of the shot-hole borer pest have been becoming more and more evident, to the low-country planter in particular. When Mr. K. G. Sinclair, the then Chairman of the Planters' Association, quoted some loss of crop figures at the meeting to which I have alluded earlier, and in view of certain information given by an officer of the Tea Research Institute at that particular meeting, it was decided that a symposium should be convened at the earliest possible opportunity to discuss the whole question.

It was hoped that the eminent Entomologist, Dr. Judenko, who was coming out specially to study shot-hole borer, would be enabled, through the vehicle of such a

symposium, to gather and collate relevant data which would indicate to him those aspects of the problem requiring urgent investigation. Meanwhile Dr. Judenko arrived in the island and established himself on Millawitiya estate which is in this district. He commenced his research work on shot-hole borer with such energy, application and keenness of mind that I cannot help feeling that the days of *Xyleborus fornicatus* as a major pest of the tea industry in Ceylon are surely numbered. Due to unavoidable circumstances the date of this symposium had to be put off more than once. However, it was all straightened out in the end and we are meeting today to listen to what our Tea Research Institute officers have to say about the problem, and to hear the views, later on, of the planting districts most concerned. I do appeal to the delegates from the various planting districts to give us their views, and the views of their colleagues who are unable to be present here today.

This conference has not been convened with the idea that the Tea Research Institute and Dr. Judenko, in particular, have any ready-made panacea to offer us. On the contrary, this meeting has been convened in the hopes that by full discussion of the subject the Tea Research Institute officers will be able to determine what will be the most profitable lines of research to pursue.

Before introducing the first speaker, there are one or two domestic points in connection with the arrangements of this conference which I would like to bring to your notice.

Firstly there will be a break of 15 minutes for tea during the morning session and a bell will be rung five minutes before the session is due to commence again. I would ask you all to be good enough to be back in your seats by the time the second bell is rung, as this will greatly facilitate the smooth running of the conference. Similarly a bell will be rung 5 minutes before the commencement of the afternoon session after lunch, and your co-operation again will be very much appreciated.

It is now my very pleasant duty to call upon the Hon'ble the Minister for Food and Agriculture, Mr. Philip Gunawardena, to address us.

ADDRESS BY THE HONOURABLE MR. D. P. R. GUNAWARDENA, MINISTER OF AGRICULTURE AND FOOD.

I am very happy to be present here to day in your midst when you are discussing a problem which is of the utmost significance to the tea industry in this country. I hope that the scientific contributions which officers of the Tea Research Institute will make at this symposium, together with the practical experience gained by the planters of Sabaragamuwa, will enable all of us at the end of this conference to come to practical conclusions as to how we should fight the menace to the tea planting industry, which the shot-hole borer has been since at least about 1892. The tea plant was introduced into this country, I understand, sometime about 1824, but its commercial use did not begin to affect the economic life of this country till about 1867. From about 1892 the damage done by the shot-hole borer has been known to tea planters, and particularly to the entomologists of the Department of Agriculture. We have heard of the names of Jepson and others, who fought in the early days in their own way the damage which this beetle was doing to the tea plant. Later you were more fortunate, and the country has been more fortunate, when tea research was begun in a more organised, systematic and continuous way after the organisation of the Tea Research Institute in 1925. Since then research officers in the Tea Research Institute have been spending a considerable part of their time in finding ways and means of fighting the ravages done by shot-hole borer to the tea plantations in this country. We are very fortunate that since last year we have had the advantage of utilising the services of the distinguished entomologist, Dr. Judenko. We have reason to believe that he has already begun to find ways and means of fighting the shot-hole borer. I believe I am correct in saying that he has at least confirmed the name of this beetle, and that his investigations into the biology of the shot-hole borer may provide an answer to this problem which can be applied by the practical planting community who have been so long engaged in the tea industry in this country. I suppose that in the paper which he will read before this house later today Dr. Judenko will tell you how far he has succeeded and what more remains to be done. So far as Government is concerned, I can tell you that any assistance, in addition to the work being carried out now at the Tea Research Institute, which you ask of the Government in order to fight and get rid of this menace, the Government will be prepared to give you. I can say that *without any fear of contradiction* because the Government realises that the tea industry brings in not only enormous revenue to the Government, but also tremendous income to this island. It is a fact that the area under tea has been declining for some time; that during the last year there has been a decline in the acreage by about 10,000 acres—from 575,000 acres to about 564,000 acres.

We do not know to what extent the shot-hole borer is responsible for this decline in acreage, but we do know that the shot-hole borer may be responsible for a decline in production of from 30 million to 100 million pounds of tea per year. This is a big amount—a very significant amount which we can save by getting rid of the shot-hole borer. By effective scientific methods of planting, by taking care of the plants after they have been planted, by enabling the plant to have greater resistance through more intensified manuring, under the instructions issued by the Institute, you may succeed in strengthening not only the stem of the tea plant, but also its branches, thus preventing the damage done through the building of galleries in the branches and

stems of the tea plant. We do not know exactly how this problem is to be tackled yet; I hope today at this symposium that the scientists of the Tea Research Institute, and practical planters of the Sabaragamuwa Planters' Association will apply jointly to the problem their research experience and their practical experience in the plantations, and will come to conclusions which will help the Government, the tea planting industry, and everyone interested in agriculture in this country to fight this disease.

I am not an entomologist, but I am vitally interested in seeing that this damage, which is done annually to the tea crop in this country, is prevented by the advice which we can get from the scientists of the Tea Research Institute. I know that a good many planters, when they start out as planters, know very little of the problems of the planting industry; but after they have planted for a few years, it must be admitted by every person that they learn a good deal. Not only do they learn a good deal, but, from what they learn on the practical side of planting, they are sometimes able to place problems before the scientists which had escaped the attention of those scientists for a very long period. This is the reason why this symposium is particularly important and we must congratulate the Tea Research Institute as well as the Sabaragamuwa Planters' Association for making arrangements to enable it to be held.

I do not propose to make a long speech. I came here not to speak but to listen; I came here not to teach but to learn. I will be here till about 12 o'clock, and at 12 I am sorry I have to leave because I have to attend to certain other matters.

There is one other matter to which I would like to draw your attention before I conclude; that is the question—my "hobby horse"—of fragmentation. This is a problem to which you must pay particular attention, because, if we allow fragmentation to proceed at its present pace, then before many years pass the tea industry in this country will be faced with a problem defying solution. The efficiency of the tea planting industry will go down. Fragmentation is as much an enemy of the tea planting industry as the shot-hole borer. We cannot close our eyes to the rapid process of fragmentation of tea estates which is going on. Since 1945 nearly 10 thousand acres of good, efficient tea plantations have been fragmented. I think I am not at all exaggerating when I say that those fragmented portions have become absolutely useless. You must fight the speculator if you are to prevent fragmentation. I am sorry that the Government in the past has helped fragmentation by assisting the speculator to get easy money. I promise you that, so far as the present Government is concerned, he will not get so easily the money from Government sources which he got during the last ten years.

Before long the Government may have to consider the question of taking more effective steps, by legislative action, to prohibit fragmentation, because the industry has to be saved, the revenue of this country has to be saved. The efficiency of the tea industry must be constantly raised up—not allowed to go down.

As I said before, I came here to listen, but I cannot help mentioning this subject to planters who have lived in this island for very long periods, who have had practical experience, and who are anxious sometimes to get rid of plantations which in their eyes are not very good. If those plantations are not very good it is the duty of planters to make them good; not to hand them over to speculators so that even their previous efficiency is reduced. I appeal to the Sabaragamuwa planters to help us in this matter, and I can tell you that, so far as the Government is concerned, we are prepared to help every person in this country who is contributing his bit to raising the productive level of agriculture in this country, whether it be tea planters, rubber planters, coconut planters or paddy growers.

I do not propose to add anything more. I thank you for the kind invitation which you extended to me and for the kind reception which you have given me.

Chairman.—I am sure that you all have been extremely interested in the Minister's very informative and instructive address. It is to me extremely comforting, and I am sure it is to all of us here today, to think and to know that the Minister and his Ministry are prepared to give the planting industry in this country all the assistance in their power.

There is no doubt at all from the Minister's address that his awareness of the shot-hole borer problem, and other allied problems, such as fragmentation of estates in this country, will very materially help the planting industry to maintain its economy which is so essential to this country's existence.

It now gives me much pleasure to call upon Senator Thomas Amarasuriya, Chairman of the Planters' Association of Ceylon, to reply to this very interesting and informative address which the Minister has so kindly just given us.

REPLY TO THE MINISTER'S ADDRESS BY SENATOR THOMAS AMARASURIYA, O.B.E., CHAIRMAN, PLANTERS' ASSOCIATION OF CEYLON.

May I in the first place offer you my apologies for not being here sharply on time. I am expected to reply to the address of the Minister of Agriculture and Food. I really do not know how to reply, or what to reply, because I missed his opening paragraphs.

However, may I congratulate the Sabaragamuwa Planters' Association for arranging this symposium at a very important time in the history of our country. I am also happy that you took the opportunity to invite our Minister of Agriculture and Food. His address, which he said was a short one, was very interesting and very inspiring. We as planters are happy that we have got a Minister with such energy and drive and we are always prepared to extend our hearty co-operation to him as far as agriculture is concerned and to give him any advice on agricultural matters which he may care to seek.

You have been good enough to promise all assistance from the Government to help settle this question of shot-hole borer. I understand you are also gratified that we have obtained the services of a distinguished entomologist. At a time when the tea industry is playing a very prominent part in the life of Ceylon and in its national economy, we are really happy and encouraged to find you, Sir, as representative of the present Government, offering us every assistance and co-operation.

Today planters are faced with very serious problems. As I have often said, these planters, who are responsible for maintaining the three main industries, tea, rubber and coconuts, wish to contribute a large portion to the national wealth of this country and to play their full part, and we are really happy, Sir, that you as our Minister have given us every hope and encouragement on this occasion.

We know that the fragmentation of estates is receiving your very serious consideration. I hope I have not in any way misunderstood you: the charge of fragmentation cannot be laid against the planters. As you yourself said, it is the work of speculators, and, if I may say so, exploiters of this country: people who buy estates, not merely for the sake of cultivating them but for the sake of making money. It is true, Sir, that in the recent past units of estates have been moving from one party to another, but as Chairman of the Planters' Association, I can assure you that, as far as the planters are concerned, no well organised and well run estate will change hands to any undesirable party. If any estate changes hands it will go to another party equally competent to run that estate. It is true that the fragmentation of estates, as it is being done today, should not be encouraged, since it is bound to have a very deterrent effect on the life of the community and the national wealth of the country.

We, as planters, hope to assist the Government in increasing the national wealth of this country and developing its resources. You yourself have said, Sir, that you are prepared in every way to support any person who contributes his share towards the development of tea, rubber, coconuts and paddy and any other crop which may contribute to the national wealth.

We are very happy, Sir, that you have taken the opportunity of addressing this symposium and, although we may have different political ideologies, we hope that you, as Minister of Agriculture and Food of this Government, will, with your usual capacity for work, with your experience of agricultural matters, with your clear thinking, and your vision of the future, in every way extend your cordiality towards the planters of this country, and see that they are able to play a greater part in improving this island and increasing its national wealth. I can assure you, Sir, as representative of the planting community, that we are always ready to co-operate with you with good will and, if you need our advice in any matter, we shall always be ready to give it to you and to see that, as far as agriculture is concerned, this country will go from strength to strength. Once again may I thank you very cordially on behalf of the planters; I hope that, during your tenure of office, you will be in a position to say that you have played your part correctly, squarely and fairly towards the interests of agriculture in this country.

Chairman,—On behalf of those here today, I should like to thank both the Hon'ble Minister of Agriculture and Food, Mr. Philip Gunawardena, and Senator Thomas Amarasuriya, Chairman of the Planters' Association of Ceylon, for the very interesting and informative addresses which they have just given to us.

It is not for me to presume to reply to these two eminent gentlemen, both of whom are so well versed in the art of public speaking, and so I have much pleasure in now handing over the Chairmanship of this conference to Mr. G. B. Portsmouth, Director of the Tea Research Institute of Ceylon. Before I do so, however, I would like to reiterate once again our very grateful thanks and deep appreciation both to the Minister and to Senator Thomas Amarasuriya.

I now hand over the Chairmanship of this meeting to Mr. G. B. Portsmouth.

OPENING REMARKS BY MR. G. B. PORTSMOUTH, DIRECTOR, TEA RESEARCH INSTITUTE OF CEYLON.

Before I come down to the technical papers, which we are to deliver at this conference, I should like to address one or two remarks to you, Mr. Minister, in appreciation of your most encouraging speech. First of all, in the presence of my Chairman, who will, I am sure, endorse my words, as will the other members of our Board, I should like to say, Sir, that I have every intention of taking up your offer of assistance as and when we may need it in the furtherance of the research required to improve and develop the tea industry. We shall most certainly take up your offer and are most grateful to you. I would also like to thank you once again for the very encouraging way in which you have displayed your confidence in the work being carried out by the research institutes of this country. It is of the greatest comfort to myself and my officers to know that we have your confidence and the confidence of your Government, and I can assure you that, as long as we retain this confidence and are allowed to carry out our research according to scientific principles, we will redouble out efforts to take care of the agricultural industries of this country, in my own case the tea industry, and to solve all the problems which are continually facing it. I would also like to stress that as scientists it is entirely our desire, and in fact our creed, that nothing but the principles of good agriculture should be applied to the agricultural industries of this island, and I was very pleased indeed to hear your remarks on fragmentation, which judged by such principles, is one of the most damaging things which can happen to our plantation industries.

We must now proceed with the technical side of this conference and I must first of all draw your attention to the bundle of tables and diagrams which was given you when you came in. You will find in these all the tables which are going to be discussed by the various speakers and the diagrams which they wish to put before you. You will appreciate that in this hall it is not possible to show lantern slides, as we have done at other Tea Research Institute conferences, and we have, therefore, taken this method of bringing figures or diagrams, which speakers wish to discuss, before you.

These tables and diagrams are in order and I would ask you please to turn to the appropriate page during the course of any particular paper.

At the moment I think that this morning we shall probably have very little time for any discussions on the papers which we are going to put before you, but this afternoon has been left for full discussion and you will have ample opportunity for raising any points which may have occurred to you after listening to the speakers this morning. Discussion is, of course, the essence of this conference and I do hope everyone will do their best to join in. I would, therefore, ask you to make a note of any particular points which you want to bring up after any of the speakers have given their papers. We will deal with them this afternoon and I will direct the particular question to the specialist officer concerned. I would at this stage also like to say to those visitors from other districts that Mr. Cowling and other officers of the Sabaragamuwa Planters' Association have gone to a great deal of trouble over this conference, and certainly we at the Tea Research Institute do very deeply appreciate all the co-operation and assistance which they have given us. I will now open the technical proceedings by giving you my talk on the shot-hole borer problem.

THE SHOT-HOLE BORER PROBLEM

G. B. Portsmouth

Although the shot-hole borer beetle is a very small insect its activities as a pest of mid and low-country tea have created a problem of the greatest magnitude for the tea industry. The scientific name of the borer is *Xyleborus fornicatus*, which though suitably expressive may well prove to be a misnomer since, as Dr. Judenko will tell you later, there are strong suspicions that the female borer may be able to produce progeny without copulation!

Shot-hole borer was at a very early date recognised as a serious pest of tea in Ceylon and was the subject of extensive researches by a number of different Government Entomologists. Two of these, Speyer and Jepson, were specially appointed for work on this particular problem. Later, with the establishment of the Tea Research Institute in 1926, responsibility for research on the pest was transferred to the Institute. This was mainly carried out in Uva at our Passara Sub-Station, which was established on Gonakelle Estate in 1935. Shot-hole borer research at Passara was largely carried out by Mr. Austin, who will be addressing you next, and who was transferred to the Tea Research Institute from the Department of Agriculture, bringing with him a wide knowledge of the previous work done on the pest. The names of Dr. Gadd and Mr. Fonseka must also be associated with these Passara experiments.

The main finding from the work carried out at Passara was that the borer attack tended to die out during the third year from pruning, which enabled the Institute to recommend the extension of the pruning cycle to three or more years as a means of reducing the damage caused by the borer.

There the matter apparently rested until I myself made an extensive tour, accompanied by Dr. Haworth and Mr. Passingham, early in 1952, of estates in the Ratnapura district. During this tour I obtained a first-hand impression of the very serious nature of the damage caused by the pest. Furthermore it was immediately apparent that the Institute's recommendation to extend the length of the pruning cycle was of little or no value in districts where, for climatic or other reasons, it was considered impracticable to run a cycle for more than about two years. The need for further research on shot-hole borer under low-country conditions was clearly evident.

Following the report of our tour a meeting with the scientific and agricultural advisers of Messrs. James Finlay & Co. was held at the Tea Research Institute, when the whole problem of shot-hole borer in the Ratnapura district was discussed in considerable detail. As a direct consequence of this meeting arrangements were made to transfer Mr. Austin from Passara to the Ratnapura district for six months to investigate the problem on the spot, with especial reference to the damage caused in young clearings.

Mr. Austin's visit entirely corroborated our opinions concerning the seriousness of the pest and led to the laying down of a number of field experiments in the district during 1953.

However, there was little progress towards any practical solution of the shot-hole borer problem under low-country conditions and in June last year, therefore, I was very pleased to be in a position to recommend to my Board the acceptance of

an offer from Messrs. Fisons Pest Control Ltd. to loan us the services of a research entomologist for work on this problem. This recommendation was accepted by the Board and Dr. Judenko arrived in Ceylon in August 1955 and set up his laboratory at Millawitiya. Since then he has thrown himself into his work with the greatest of keenness and has demonstrated that it would have indeed been difficult for the Institute to have found a special research officer better fitted to deal with the problem allotted him.

However, I must sound a note of warning at this point. The shot-hole borer problem is one which has occupied the attention of a succession of entomologists for the past 50 years and, although Dr. Judenko has the advantage of being able to bring all the recent advances that have been made in entomological science to bear on the problem, he is no miracle worker and our hopes of his being able to produce a practical solution in a short time must not be cast unduly high.

There is little real information regarding the extent of the losses caused by the borer and estimates of experienced planters, which will be brought to your attention later today, range from 100 to 300 pounds per acre per annum in old tea to as high as 500 to 700 pounds per acre in new clearings. In this connection some calculations of the average yields per acre for tea in the different elevation categories may be of interest. The figures were abstracted from the Tea Controller's report for 1953/54 and are before you as Table I.

Table 1. *Figures Abstracted from the Report of the Tea Controller for the tea control year* 1953/54

	High	Medium	Low	All
Elevation	Above 4000'	2000-4000'	Below 2000'	
Acreage.—				
Estate	185,927	198,317	120,225	504,469
Small Holdings*	5,582	40,194	24,005	69,781
Total	191,509	238,511	144,230	575,250
Total yield lbs.	151,090,137	133,953,650	68,771,997	353,815,784
Yield per acre lb.	789	562	477	616
Diff: from general average	+173	—54	—139	—
Total crop lost below general average	—	12,879,594	20,047,970	32,927,564
Diff: from high-grown average:	—	—227	—312	—
Total crop lost below high-grown average	—	54,141,997	44,999,760	99,141,757

**N.B.*—Allocation of acreage between the different elevation categories is only approximate.

One glance at these figures is enough to reveal the truly astounding information that, despite the much higher growth rate of the tea at the lower elevations and much less liability to blister blight attack, the average yields per acre for mid and low-country tea are well below the all Ceylon average, and very much lower than that of the much slower growing high grown tea. There must clearly be some highly

significant factor operating to produce this very large departure from normal expectation and my own opinion is that this factor is none other than that most inconspicuous little beetle, *Xyleborus fornicatus*. If this supposition is correct, and to-date no other equally significant factor affecting yields of mid and low-country tea has been brought to light, then the extent of the losses caused by the borer must indeed be tremendous. Some indication of what these losses might be is given in the table. Thus, if the effects of the borer only operated to depress mid and low-country yields below the all Ceylon average, some 30 million pounds of tea would be being lost per year. However, if its effects were, as they well might be, still more serious and operated to depress mid and low-country yields below the high grown average, then up to 100 million pounds of tea might be being lost per year. Potential losses of this extent are indeed a serious matter to both the tea industry and to Ceylon's economy and clearly indicate that the problem of shot-hole borer merits the closest attention of both the Institute and of the tea industry.

To make sure that the yield trends obtained for 1953/54 were not purely fortuitous I have taken out similar figures from the Tea Controller's report for 1954/55. These are before you in Table 2 and you will see that, although the general level of yields has risen, the same tendency for abnormally low mid and low-country yields is almost exactly repeated. Clearly this is not any chance effect.

Table 2. *Figures abstracted from the Report of the Tea Controller for the tea control year* 1954/55.

	High	Medium	Low	All
Elevation	Above 4000′	2000-4000′	Below 2000′	
Acreage	191,779	233,697	150,008	575,504
Total yield lbs.	155,834,907	143,782,477	77,850,350	377,467,734
Yield per acre lbs.	812	615	519	656
Diff. from general average	+156	—41	—137	—
Total crop lost below general average	—	9,581,577	20,551,096	30,132,673
Diff. from high-grown average	—	—197	—293	—
Total crop lost below high-grown average	—	46,038,309	43,952,344	89,990,653

What now are the principal ways in which borer attack affects yield? To my mind there are several. Firstly, a severe infestation in young clearings prevents the development of good frames. Secondly, the continued increase in the number of galleries below the pruning level eventually leads to a failure of many, otherwise well developed, frame branches to recover from pruning, with a consequent reduction in frame size and loss of yielding capacity. That this is perhaps the most serious effect of borer infestation is supported by the yield pattern shown by many young fields in the Ratnapura district. Here the fields reach their highest yield level of 1,500 to 2,000 pounds per acre within about 10 years from planting and then decline steadily to yield levels of less than 1,000 pounds per acre. Thirdly, as Mr. Webster will tell you later, branch breakage, due to the presence of borer galleries, is probably one of the commonest ways of entry of the woodrot which is such a prominent feature in mid and low-country tea.

There are, of course, many ways in which we can attempt to minimise the loss of yield caused by the borer. Thus, as Mr. Tolhurst will tell you, generous manurial treatment, especially an increase in potash applications, may well keep yields up. However, the interaction of manurial treatments and borer incidence is a long term problem which needs time to evaluate. In this connection it is not inappropriate to point out that more vigorous plants may tend to be more attractive to pests, and that high yields from this cause may prove to be correlated with a higher degree of infestation. This is a situation which clearly requires watching, since a short term palliative measure may turn out to have disastrous long term effects.

Pruning practices are likely to considerably affect borer incidence and here Mr. Walter's contribution is of interest. However, in considering what he puts forward in relation to past research, I trust you will remember that modern systems of pruning at the lower elevations were only introduced after Dr. Tubbs's investigations on starch deficiency in the nineteen thirties. Pruning must, however, be carried out intelligently and obviously pruning heavily infested bushes at a time when recovery must take place into dry weather is likely to lead to increased dieback.

The whole shot-hole borer problem is of a nature which enables intelligent action by the practical planter to play a large part in preventing unnecessary damage. Thus, for example, any cultural operation which will lead to increased branch breakages during the very susceptible second year of the cycle should be avoided if possible. Deep forking of second year fields, and similar operations, belong to this category and are best avoided or else modified to suit prevailing conditions.

Turning now to the various lines of attack against the borer which are open to us, the most important is clearly to have a full understanding of the biology of the pest. Dr. Judenko has been working on this aspect of the problem and has already gone a long way towards clearing up a number of outstanding gaps in our knowledge. He hopes shortly to be in a position to extend his researches to possible methods of control.

Here fortunately we have two lines of attack open to us, since control of the pest can be effected either by direct control of the borer itself or by control of the ambrosia fungus on which it rears its brood. The opportunity that exists here for the development of suitable systemic insecticides or fungicides is clearly a big one.

Direct insecticidal control of the borer has, of course, already been tried out and, of the many insecticides tested, dieldrin has given most promise of effective control. Unfortunately the use of this insecticide can not be recommended by the Institute, since it has very serious effects on the existing biological balance between tea tortrix and its controlling parasite, *Macrocentrus homonae*. Apparently dieldrin is much more effective in killing off Macrocentrus than it is against tortrix, with the result that uncontrolled tortrix attacks tend to develop on treated areas. Furthermore dieldrin belongs to the new range of chlorinated hydrocarbon insecticides, regarding which much concern is now developing in scientific circles on account of their cumulative toxic effects on humans. The widespread use of such an insecticide on a food crop like tea can not therefore be endorsed by the Tea Research Institute, until much more information concerning the long term effects of repeated small intakes on humans becomes available.

Reports have been received recently that certain clones appear to be much less liable to borer attack than others. If these observations are substantiated, then the selection and multiplication by vegetative propagation of planting material resistant to borer attack opens up yet another avenue worth exploring. Any field observations regarding bushes which appear to be resistant to borer attack will accordingly be welcomed by the Institute.

Finally, I would like to again remind you that one of the purposes of the present Symposium is to stimulate an exchange of ideas on the shot-hole borer problem between all interested parties. Many of the contributions to be made today may be expected to contain novel and interesting views on the subject, which may well serve to trigger off new and profitable lines of research. I will therefore close by asking all those attending today to please bring forward any suggestions and observations they may have without reservation during the discussion session which we shall be having this afternoon. Entomology is a science which in the past has been largely developed by amateurs with keen observation, and who can say whether one of the points brought out today will not supply the key to effective shot-hole borer control in the future.

HISTORICAL REVIEW OF SHOT-HOLE BORER INVESTIGATIONS

G. D. Austin

Shot-hole borer, (*Xyleborus fornicatus*), has been recognised as one of the most serious pests of tea for the past sixty years and for several years was the subject of almost continuous study. No insect pest in this country has been investigated by such a galaxy of experts—first by Green (1898-1913), Rutherford (1913-1915), Speyer (1914-1919) and Jepson (1920-1926) of the Department of Agriculture; then from 1936 by Stuart Light, Redman-King, Gadd, Baptist and, since August 1955, Judenko of the Tea Research Institute of Ceylon.

Partly owing to its wide range of distribution, in that it appears in tea from an elevation of 4,000 feet downwards, there is probably no other insect pest of tea in Ceylon with which planters are more familiar, by name if not experience, or which has been more prominently before the planting public, than this little beetle.

The first mention of *Xyleborus fornicatus* was in 1868 when the female beetle was described by Eichoff from a specimen collected in Ceylon. Unfortunately there is no record either of the locality or of the host plant from which Eichoff's type specimen was secured, but since it was at this time that the tea industry was established in the island it is possible that Eichoff's specimens were obtained from the tea plant.

It is not known whether the insect is indigenous to Ceylon or whether it has been introduced. Outside Ceylon this species is known to occur only in Java, Malaya, Formosa and India. If introduced, therefore, it probably originated from one of these countries and may have been established in some growing plant which had been imported.

It is interesting to record that Speyer was of the opinion that there were two races of this species—a large and a small one. Both races attack *Albizzia falcata* with equal frequency but the larger race is more often found in *Ricinus cummunis* (the castor oil plant) and *Erythrina lithosperma* (the common dadap) while the smaller one predominates in tea.

In 1890, Mr. E. E. Green, at that time a tea planter and subsequently Ceylon's first Government Entomologist, published a book entitled "Insect Pests of the Tea Plant". Although most of the familiar pests of tea are dealt with in this work, it is interesting to find that no mention is made of shot-hole borer, from which it may be concluded that the insect at that time was not considered a pest of tea. In 1892, however, it was reported on tea for the first time when it appeared on Craighead Estate, Nawalapitiya.

In 1903 the beetle had invaded Uva and the Government Entomologist reported that this Province, which from its position was usually the last to be affected by new pests, had not escaped, the borer having established itself in the Haputale and Badulla districts.

The same year Green published a most readable description of the beetle, giving an account of its life history and habits in the "Circulars of the Royal Botanic Garden, Peradeniya". Even after half a century this publication is still the best account of the pest.

In 1907 it was declared a pest under Ordinance 7 to check its internal distribution.

By 1909 Green was considering biological control, and subsequently imported a predacious beetle (*Clerus formicarious*) from Scotland. But when the consignment arrived it was found that the larvae of *C. formicarious* were too large to live in the galleries of *Xyleborus fornicatus*!

By 1910 the pest had appeared in Sabaragamuwa when it was observed to have spread in the Balangoda and Ratnapura districts. Invasion is reported to have occurred through infested planting material brought over from the Ambegamuwa and Lower Hewaheta districts.

By 1912 the ordinance passed previously had been proved ineffective and the beetle was declared a pest within the meaning of Ordinance No. 6 of 1907, which made it compulsory for an affected estate to report its presence to the Department of Agriculture.

In 1913 Green resigned his post of Entomologist and was succeeded by Andrew Rutherford. During the brief spell of two years—until his untimely death in 1915—Rutherford concentrated his investigations on a study of the insect underground. The results of his experiments proved that the beetle could live, breed and multiply in prunings, buried to any depth consistent with estate practice. Rutherford was of the opinion that the burial of prunings, as a means of control, was useless, and that certain disadvantages would accrue from the concentration of so much decaying organic matter in close proximity to the roots of the tea plants. He therefore recommended burning of the prunings as the only effective method of control.

1914 saw the appointment of E. R. Speyer as Special Entomologist to investigate the shot-hole borer problem. Speyer was in the island until 1919 and carried out his investigations at Peradeniya and at Poonagalla Estate in Uva. He made a careful study of the problem and published his findings in 23 papers, which appeared in the Tropical Agriculturist, and as leaflets and bulletins of the Department of Agriculture. His first big work the "Treatment of Prunings on Infested Estates" dealt with his experiments to ascertain the effect of the disposal of prunings on the habits and propagation of the beetle. His chief findings, in his own words, were that "when prunings are buried to depths varying from 4 to 18 inches below the ground, with or without the manurial mixtures commonly used on estates, development in the woody stems proceeds normally below the ground for a period of at least 30 days. From these depths adult female beetles may continue to reach the soil surface during a period of at least 56 days in dry weather and for a lesser period in heavy rains".

Speyer's results corroborated those of Rutherford that the wholesale burial of prunings was not an efficacious measure of control. He, therefore, suggested that the soundest method of disposing of prunings was to "slash off the leaves and small twigs from the branches after they have been cut from the bushes. These are buried in holes or forked into the soil, and the remaining thicker wood is burnt immediately, and the ashes returned to the soil. Leaving the prunings on the ground and burying the prunings, both allow adult beetles to escape".

Speyer's next investigation was a control pruning scheme and the application of a special paint to be applied to the collars and lower branches. The chief aim of the paint was "to prevent insects escaping from the bushes between the time of pruning and the output of new shoots and also to protect the 'eyes' of the branches from attack by borer".

Speyer was also of opinion that the true host of *Xyleborus fornicatus* was the castor oil plant, *Ricinus communis*, and that the only remedy was the complete extermination of this plant throughout the whole tea growing area. He also proposed to break up the vast tea areas by shelter belts of immune trees and undergrowth, in order to check migration and facilitate control.

With the departure of Speyer in 1919, F. P. Jepson was appointed Special Entomologist for shot-hole borer investigations and he worked on the pest until 1926. Jepson too carried out part of his investigations in Uva, on Sarnia Group near Badulla. His first assignment was to try out some of Speyer's recommendations relating to the control pruning scheme and "Speyer's Mixture" and the treatment of buried prunings on shot-hole borer infested estates. Jepson's experiments indicated that Speyer's control pruning scheme resulted in too severe a mutilation of the bush to warrant its adoption; the paint mixture was too costly to be used generally and tended to cause injury to the bushes and promote die-back.

Jepson was not content to pursue only the lines of research hitherto followed, because this work had been almost exclusively confined to the investigation of measures designed to reduce the numbers of the pest. He, therefore, decided to investigate the possibilities of agricultural methods with special reference to manuring.

He was also not satisfied with Speyer's recommendation relating to the destruction of prunings. He, therefore, decided "that the action of all manures, in common use, should be tested (with buried prunings) as in the event of a fertiliser being found to have a beneficial agency in causing the death of the inmates below ground, it would, at the same time, augment the fertilising value of the prunings". The results were most disappointing and Jepson had to fall back on Speyer's recommendation to lop the smaller prunings, bury them, and burn the larger branches.

Jepson next launched a series of manurial experiments. The first, which was of a preliminary nature, was a trial with a selection of individual manures to ascertain the effects of nitrogen, potash and phosphoric acid upon shot-hole borer. Gadd, then Assistant Mycologist in the Department of Agriculture, analysed Jepson's data and their conclusion was that potash was beneficial except when combined with nitrogen as nitrate of potash.

These results encouraged Jepson to determine the effects of a complete fertiliser applied at varying rates per acre, and of several artificial manures. The results may be summarised as follows:—

The manuring of tea does not definitely impart any degree of immunity to the bushes against shot-hole borer attack, though the complete manure mixture plots showed more empty galleries than the controls. Manuring, however, definitely promotes healing over of the entrance to the galleries.

Jepson also looked into the possibilities of biological control. He considered that the prospect of controlling shot-hole borer by means of natural enemies "was not promising", but that its possibility should not be dismissed until a thorough search had been made for enemies of the pest in countries other than Ceylon, where the species was known, or might later be found to occur.

As to chemical control Jepson was of opinion that while insecticidal measures were an invaluable method of controlling many pests they could not profitably be adopted against shot-hole borer.

His final recommendations at the Agricultural Conference at Peradeniya in March 1926 were that "shot-hole borer cannot be exterminated or economically reduced, nor can the bushes be protected against attack. They can, however, be so

stimulated by systematic and suitable manuring that the damage caused by the borer is inconsiderable and in some cases almost negligible."

1926 saw the establishment of the Tea Research Institute of Ceylon. The investigation of shot-hole borer and other pests of tea was passed on by the Department of Agriculture to the Tea Research Institute. Jepson's recommendations continued to be advocated by the Institute until a further enquiry into the shot-hole borer problem was opened at the newly established sub-station at Passara towards the end of 1935.

From 1936 onwards the problem was investigated by Austin and Fonseka at Passara, and the results of their experiments were published in a series of papers by Redman-King and Gadd in both the *Tea Quarterly* and the Annals of Applied Biology. An early achievement was the determination of the life history of the beetle under field conditions—hitherto never attempted by earlier workers.

The life history was recorded as follows:— from the commencement of boring a gallery to egg-laying, 8 days; egg period, 7 days; larval stage, 15 days; pupal stage, 7 days. The life cycle, therefore, from egg to egg was found to be about 40 days. It was also observed that beetles were most active during the warmer parts of the day, emerging from galleries between 10 a.m. and 2 p.m. Green and Speyer had studied the behaviour of the beetles and recorded that they flew a certain distance and Speyer was emphatic that they were not attracted to lights at night. Mating was never observed.

Ten years later Gadd and Loos described the Ambrosia fungus present in galleries, as *Monacrosporium ambrosium*. Speyer had earlier referred to *Monacrosporium* as a finding by Petch and he himself had also observed the spores of the fungus within galleries about 7 days after the female beetle had commenced to bore a gallery in the stem. The same year (1946) Gadd succeeded in rearing the beetle from egg to adult in artificial cultures of *Monacrosporium ambrosium* at St. Coombs.

Damage to the tea bush is assessed as follows:— Primary damage is caused during the construction of galleries in the stems. This of itself would be of little importance were it not for other consequences which result more or less accidentally from the presence of the galleries. The consequences, really secondary damage, are:— (1) die-back, (2) wood-rot, (3) branch breakage. The last named is the most important as it leads to the greatest loss of crop.

Very interesting information was next collected from the Passara N.P.K. experiment. This experiment was designed and laid down by Eden, with the object of determining the effect of manurial treatments on the yield of tea in a shot-hole borer infested area of the Passara district, at an elevation of 3,500 feet above sea level. The treatments were as follows:—

(1) No manure.

(2) Nitrogen alone at the rate of 40 lbs. per acre per annum.

(3) Potash alone at 40 lbs. per acre.

(4) Phosphate alone at 30 lbs. per acre.

(5) Nitrogen and potash together.

(6) Nitrogen and phosphate.

(7) Potash and phosphate.

(8) A complete mixture of nitrogen, phosphate and potash.

Where more than one element was used the quantity of each was the same as that applied alone.

Jepson's experiments had indicated that nitrogen, potash and phosphates all tended individually to promote the healing of galleries. It was assumed that such healing would be beneficial in preventing branch-breakage, and Gadd, therefore, analysed Jepson's data and also the data collected at Passara to answer the question: "Does the use of manures reduce the number of broken branches?" To quote Gadd: "Manuring does not reduce damage caused by shot-hole borer. The number of broken branches collected from the experiemntal plots was greatest in the plots giving the heaviest crops. Nitrogen caused the greatest increase in yield; it also caused the greatest increase in insect damage". Furthermore, it was subsequently proved that in any case healing of galleries in no way prevented branch breakage.

Another experiment proved that there was a definite relationship between shot-hole borer and wood-rot; both die-back and wood-rot were more extensive in shot-hole borer infested branches than in non-infested branches.

Earlier experiments at Passara also indicated that:—

(1) Attack by shot hole borer does not become of economic importance during the first year from pruning.

(2) The main period of attack is usually in the latter half of the second year when the number of galleries increases.

(3) The attack dies out in the third year.

(4) Sufficient occupied galleries are left after pruning to ensure an attack during the next pruning cycle.

(5) Such measures as the burning of prunings can do little or nothing towards preventing a later attack.

(6) The heavy mortality amongst adult beetles, coupled with the mortality that occurs in the galleries, raises doubt that the presence of a parasite would materially improve matters.

During 1952, an intensive six months' study of the pest in new clearings was undertaken by the Assistant Entomologist on an estate in the Ratnapura district. The following are a few of the main observations recorded:—

(1) *Xyleborus fornicatus* and *X. compectus* were the only two species of borer met with, *X. fornicatus* being the commoner species.

(2) Nursery plants, supplies and young tea in clearings are liable to attack when plants are 12 to 18 months old.

(3) Early attacks are slight.

(4) Severe infestation occurs when plants reach their fourth year from planting, and are ready for plucking.

(5) Destruction or removal of prunings does not contribute to a decrease in the intensity of future attacks. This observation corroborates evidence first obtained at Passara.

(6) No parasitic or predacious insect was found in the thousands of galleries dissected.

(7) The whitish exudation, frequently found within galleries, and occasionally emanating from entrance holes, and associated with dead beetles and larvae, was found to be a species of saprophytic bacteria.

(8) Of several insecticides tested, Dieldrin gave the most promising results.

In 1953 a few field experiments were laid down in Sabaragamuwa, the more important of which were to determine (1) loss of crop, (2) age of young tea most susceptible to borer and (3), the feasibility of chemical control in clearings.

A feature of these experiments was the appearance and persistence of tea tortrix in the sprayed areas, especially in those treated with Dieldrin. This underlines very forcibly the risks of applying new persistent insecticides, the effects of which are unpredictable on the natural enemies of insects other than the pest to be controlled.

Dr. Baptist, during the short period he was in the Institute, made a study of the problem. In a paper in the *Tea Quarterly* entitled "Tea Leaf-eating Tortrix Caterpillar as a Limiting Factor in Insecticidal Application on Tea" he indicated that insecticidal applications should only be made in the period immediately following pruning.

1955 saw an intensive study of the pest being launched in a search for clonal material resistant to borer; a resolution from the Sabaragamuwa Planters' Association that there should be a symposium on shot-hole borer; and the arrival of Dr. Judenko to investigate the problem.

RESEARCH WORK ON SHOT-HOLE BORER OCTOBER, 1955, TO AUGUST, 1956

E. Judenko

Professor Azzi, an Italian scientist, said that the plant should be considered as a machine, transforming what is available to it from its environment into yield. To emphasize the economic aspect, I should like to alter Professor Azzi's expression and say that the plant should be considered as a machine transforming these environmental factors into money.

Any useful treatment against shot-hole borer must not only prevent shot-hole borer injury to the bushes, but also increase the amount of money these tea bushes will produce. From the national point of view the treatment must increase the revenue from the export of tea, and from the point of view of the individual owners it must increase profit.

I started my work on shot-hole borer about one year ago. So far no practical recommendations have emerged from my work. This indeed is not surprising since during the period under review I have worked mainly on the biology of the pest. To emphasise the importance of the biological aspect of the problem I should like to describe briefly the history of the research work which was carried out in the campaign against malaria.

Research work on the biology of mosquitoes was started about 1670 by a Dutch Zoologist, Swammerdam. A Scotsman, Ross, who was working in India as a doctor, found in 1897 a parasite of malaria in the stomach of a mosquito. In 1873 an Austrian Chemist, Zeidler, discovered DDT, but he did not realize that this chemical was able to kill insects. This was proved at the beginning of the last war by Muller, a member of the Swiss firm Geigy. After further experiments DDT sprayings were introduced against mosquitoes, and as a consequence malaria has been practically wiped out in many countries.

Many thousands of people, perhaps some in this room, owe their lives to the work done by the scientists whose names I have just mentioned. Few of them, however, realise how long the research work continued on the problem. Quite understandably the majority of sick persons are interested only in the treatment of their illnesses and not in the history of the research work involved. Similarly tea planters would like to know what treatment to apply against shot-hole borer; this and nothing more. Unfortunately, however, no treatment has yet been found against shot-hole borer.

Shot-hole borer was discovered as a pest of tea in this country in 1892. At that time the most important human diseases were malaria, tuberculosis, syphilis and cancer. Medicine has made great advances in the case of the first three of these diseases, but less so in the case of cancer, possibly because the whole biology of this disease is not yet known. Valuable research work on shot-hole borer was started in this country in 1898, but although many points were cleared up by 1955, some details regarding the life history and habits of the pest are still unknown, and this may be one of the reasons why no practical recommendations against shot-hole borer have yet been made. When I joined the Tea Research Institute, the Director, in our first discussion, drew my attention to the biological aspects of the problem,

pointing out that the method of the pest's distribution from bush to bush and from field to field was still unknown; even the proper scientific name of the insect required to be confirmed.

I have begun my work, therefore, by making a study of the biology of the beetle, and I will now give you a brief account of my investigations to date.

Identification of the Pest.—Since there was some disagreement among entomologists as to the identity of the beetle, samples were sent for identification to Professor Dr. K. E. Schedl, a senior entomologist of the Federal Forest Research Institute of Austria, who kindly agreed to do this work. Out of 2,963 beetles, collected from dissected branches pruned at Alupolla Group, Denawaka Group, Hedgefield Estate and Millawitiya Estate, Professor Schedl found that all except two belonged to *Xyleborus fornicatus* Eichoff.

The Number and Proportion of Beetles found outside Galleries on Tea Bushes.—In order to find out the number and proportion of beetles living on tea bushes outside the galleries, sticky traps are kept on tea bushes on four estates and beetles are being shaken off bushes on two estates at monthly intervals.

Method of Distribution.—Observations under laboratory conditions, and in the field, have shown that females are able to fly to a height of 5 feet. A sticky trap, 14 feet high has been placed in a field, the bottom of the trap being 6 inches above the soil surface. Beetles obtained from the traps, and those shaken from the bushes are sent to Professor Schedl for identification.

Reproduction.—In the animal kingdom the normal reproduction ratio of male to female is approximately 50:50. In the case of shot-hole borer this ratio is at least 25:75. This sex ratio, and also the fact that, unlike the female, the male can neither fly nor make galleries, permits the supposition that the females are parthenogenetic. The economical importance of insects which reproduce in this manner is usually greater and control more difficult than in the case of insects which reproduce normally.

To clear up the question of the mode of reproduction of shot-hole borer, Dr. B. E. Wolf of the Institute of Genetics, Berlin Free University, Germany, is kindly carrying out investigations with insects obtained from the low-country of Ceylon.

Influence of Moisture on Shot-hole Borer.—Beetles, obtained from dissected prunings and kept in a container with water, lived for a period of from 1 to 16 days (average 4 days), whereas beetles kept simultaneously in an empty container did not live for more than one day. Infested prunings, which were dissected after immersion in water for about 1 day, were found to contain live beetles.

Laboratory experiments showed that emergence of the beetles from prunings was more rapid under dry than under wet conditions, and that subsequent mortality soon after emergence was higher. During the rainfall period 33 per cent of the emerged beetles survived long enough to fly away, whereas during the dry period only 6 per cent of the females flew away. Further preliminary experiments suggest that in dry conditions the ability of the surviving beetle to infest tea is less than under wet conditions.

Clearly the insect is very susceptible to any deficiency of moisture, and the presence of adequate moisture is vital to its development and ability to infest tea.

Influence of Direct Sunlight on Shot-hole Borer.—These experiments were carried out during a sunny period in April 1956, and were repeated in August when cloudy conditions prevailed. Prunings, cut into pieces 4 inches long, were spread in

one layer between rows of newly pruned tea. It was found that far more of the beetles died in the galleries during the sunny period than when the sun was covered by clouds.

Assessment of Infestation.—Assessments of the degree of borer infestation have in the past been based mainly on (a) the number of broken branches and (*b*) the presence of chlorosis. Neither of these methods is entirely satisfactory, since, as you will later hear from the papers by Mr. Illankoon and Mr. Tolhurst, the number of broken branches may often depend on the strength of the wind, and the chlorosis may occur independently of shot-hole borer.

It is most important to establish an objective standard for measuring the degree of infestation. The following method is now under investigation. A piece of live branch, 4 inches long, $\frac{3}{8}$ inch in diameter at the base and top, and free of any secondary branch or green shoot, is taken as a standard unit. One hundred such units are taken at random from a field, and the number of galleries per hundred units is counted and used as a measurement of the degree of infestation.

To date assessments have been made in five fields. In two of these, which were not considered by the superintendent to be suffering from borer damage, the number of galleries per 100 units was 35 and 46. In the other three fields, which were considered to be suffering damage, the number of galleries per hundred units was 123, 148 and 186. Further assessments will be made, on all the Institute's low-country field experiments.

Conclusion.—I would like to make one final point. I have been told, directly or indirectly, that some planters are expecting me to find a satisfactory treatment against shot-hole borer. I cannot give any guarantee of this. It would not be proper for any research worker starting a problem to promise success. This is a very difficult problem which has been tackled by many entomologists in this country without any practical recommendation resulting. However, I would like to assure the Hon'ble Minister and you planters, that, as long as I work in this country, I will do all I can to solve the problem.

Mr. Portsmouth.—I am sure all of you very much appreciate Dr. Judenko's keenness in this matter, and I would again say what I repeated earlier—if we do not find a solution to this problem it will not be for lack of trying; but we cannot guarantee anything.

I have now been informed that the Director of Agriculture will be leaving with the Minister, and I would like him to say a few words before he goes. I will now call upon Dr. Paul to address us.

ADDRESS BY DR. W. R. C. PAUL, ACTING DIRECTOR OF AGRICULTURE

I am very happy that an opportunity has been afforded me as representative of the Department of Agriculture to be present here and participate in these deliberations. It may be questioned as to what relevance the Department of Agriculture has in a symposium of this sort. You may have heard from the earlier speakers that the first work done on shot-hole borer was by the staff of the Department of Agriculture and it was only after the establishment of the Tea Research Institute that this work was transferred to that Institute. The Department of Agriculture diverted its attention thereafter to work which was considered more important, more appropriate for the development of the agricultural conditions of this country. It must not be felt, however, that the Department has lost its interest in tea production. I can assure you that the Department of Agriculture will continue to watch with great interest the work which is done by the Tea Research Institute and the problems which face the tea planter. We have in our own small way a few demonstration plots on our agricultural farm schools.We teach those who come there the elementary principles of tea cultivation and therefore this problem of shot-hole borer is of vital importance to us. My own interest in this problem is almost archaic. When I first joined the Department about 30 years ago my first assignment was to carry out field observations on shot-hole borer. I have almost forgotten much of what I did at that time. Mr. Austin tried to refresh my memory this morning but unfortunately both he and I have lost sight of the paper which I prepared at that time. I must thank you very much for having given me this opportunity to speak to you and to assure you of the continued interest of the Department of Agriculture in the work of the Tea Research Institute and the problems of tea planters.

Mr. Portsmouth.—Thank you very much indeed, Dr. Paul. We have been very fortunate today in having not only the Hon'ble Minister with us, to give us his assurance of his very keen interest in the work of the Institute and the tea industry, but you also, to reiterate the continuing interest of the Department of Agriculture in our work. For my part, I have always found the officers of the Department of Agriculture extremely co-operative, and they have undoubtedly given us very valuable assistance; I hope that the Tea Research Institute in its turn will always be able to give such help to the Department as it may ask us. I would certainly like to assure you, and the Hon'ble Minister, that this happy co-operation will be continued and I hope even increased in the future.

Mr. Cowling.—The Hon'ble Minister has indicated to me that, as he is extremely busy and has other places to go today, he will not be able to stay and have lunch with us, and I am sure that you all will regret it as much as I do. Before the Hon'ble Minister takes leave of us I would like to thank him, on your behalf, and on behalf of the planters of Sabaragamuwa, for very kindly coming here, and I would like to express our deepest appreciation to him, not only for giving us a very interesting address but, as the Director of the Tea Research Institute has said, for giving us assurances as a planting community of his Ministry's continued interest and future help for us.

The Minister left at this stage.

Mr. Portsmouth.—We will now resume our programme and I will call upon Mr. Webster to read Mr. Walter's paper.

FIELD OBSERVATIONS ON THE PEST IN THE LOW-COUNTRY

T. E. Walter

Note.—*Mr. Walter left the service of the Institute on August 16th 1956, and his paper was read by Mr. Webster.*

It is unfortunate that Mr. Walter, having left Ceylon, is unable to be present today, and he expresses his regrets, but it is particularly unfortunate as he will be unable to elaborate certain of the personal opinions based on his observations. However, I shall do my best to stand in for him and wish to make it plain, at the outset, that these views and suggestions are intended to stimulate discussion, and are purely subjective, being based on observed secondary effects of infestation.

Mr. Walter first put forward the case for a pruning cycle of approximately 18 months at the Tea Research Institute Conference last year, and was somewhat disappointed that his proposals were received with considerable reserve, not to say scepticism. However, a certain amount of experimental evidence is now available to support the original contention, namely, that a cycle of 18 months, plus or minus a month or two, is a feasible method of limiting loss of crop due to shot-hole borer. I will now continue in Mr. Walter's own words.

"It is, of course, of the utmost importance to realise that these remarks refer specifically to the low-country; I have not been able to define the range of elevation with any precision, but an 'informed guess' places this range as being up to at least 2,000 feet. The main criterion appears to be whether die-back—usually accompanied by sun-scorch—occurs, and low-country planters are all too familiar with these symptoms. In my opinion, the fact that these symptoms do not occur in, say, Uva largely explains why entirely different cultural methods of control have been found to be applicable there, as a result of the experiments carried out over many years by Gadd and Austin.

Before going any further it would be as well to give some rather more detailed observations on the effects of shot-hole borer in the low-country, with particular reference to the age of the tea from pruning. These effects appear to be at their maximum in the dry weather months of the second year of the cycle; the exact number of months from pruning does not appear to be significant in itself, and as there is a pruning period extending over 9 months in those parts of the low-country which receive both monsoons, the actual age from pruning at which shot-hole borer effects are at their maximum may vary between 14-23 months. In practice, fields pruned in May-July can expect to suffer set-back from shot-hole borer at 18-20 months onwards, at which stage the tea is particularly vulnerable, probably because the new wood developed has reached the most attractive stage for the beetle. On the other hand, fields pruned in September-November may expect a less severe attack at a correspondingly earlier stage in the cycle. It can also be stated without much fear of contradiction that the tea appears to be at its most susceptible stage during the second year of the first and second cycles in bearing.

Apart from these rather general observations, I have not been able to find any definite pattern of incidence which might account for the very wide variations of incidence on neighbouring estates, and even different fields on the same estate.

Following these observations—which are intended only to give a broad outline of the problem—I now come to the question of variations in cycle lengths as a means of limiting the effects of the borer and hence of lessening loss of crop. Dealing first with the experimental data as supplied in the Ingiriya pruning cycle experiment, the information which this gives can best be visualised by referring to the graph showing the yields of the various cycle lengths to date. Figure 1.

The salient features of the composite graph are as follows —

i. The yield graph of the 18 month cycle plots rises very steeply after the first prune, in spite of being pruned into the dry weather and the slow recovery entailed, we find that at the end of their second cycle they are 4.0 lbs. ahead of their nearest rivals, the 3 year cycle plots.

ii. The two year cycle plots reached the end of their first cycle without the die-back previously observed being reflected in any appreciable loss of crop. This is emphatically not usual the case in severely affected areas, and merely emphasises that the attack experienced at Ingiriya was not a major one.

iii. After 2 years, however, the yield of the plots which remained unpruned fell off markedly.

iv. After 3 years the 18 month and 3 year cycle plots maintain maximum rates of increase to date. The same applies to the 2 year and 2½ year cycle plots, but their rate of increase is not so rapid as the others.

The preliminary results of this experiment after running for 4 years are summarised in the table below.

Table 1. *Ingiriya experiment. Crop yield.*

Cycle length	Total yield after 4 years (to end June 1956) in lbs/acre	Yield expressed as a percentage
18 months	4,350 lbs.	100%
3 years	4,142 lbs.	95%
2½ years	3,830 lbs.	88%
2 years	3,802 lbs.	88%

So much for the direct experimental evidence regarding varying cycle lengths, and I now come to the rather more complex question of whether these results can be expected to be applicable to other low-country estates which are more severely affected by shot-hole borer. I am well aware that there is strong divergence of opinion on this point, and in the absence of complete experimental data covering all conditions I can only put forward my own observations in support my case.

In my opinion undoubtedly the most important factor which determines whether an 18 month cycle length is applicable to any severely affected low-country estate is—*the type of pruning*.—To illustrate this point, I would mention that I have been informed in no uncertain terms that an 18 month cycle was tried on some low-country estates, while I was still in the cradle and was found to be a complete

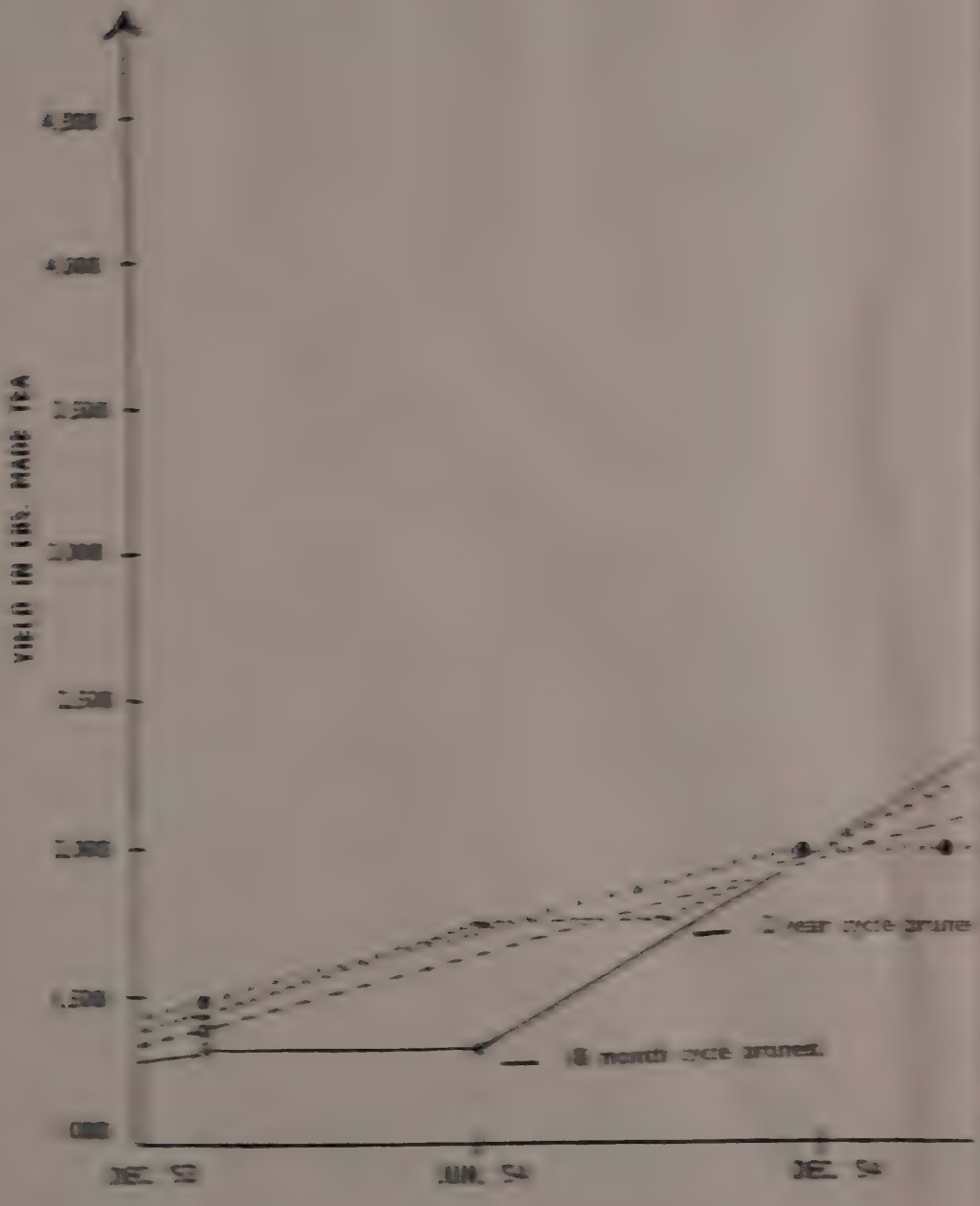
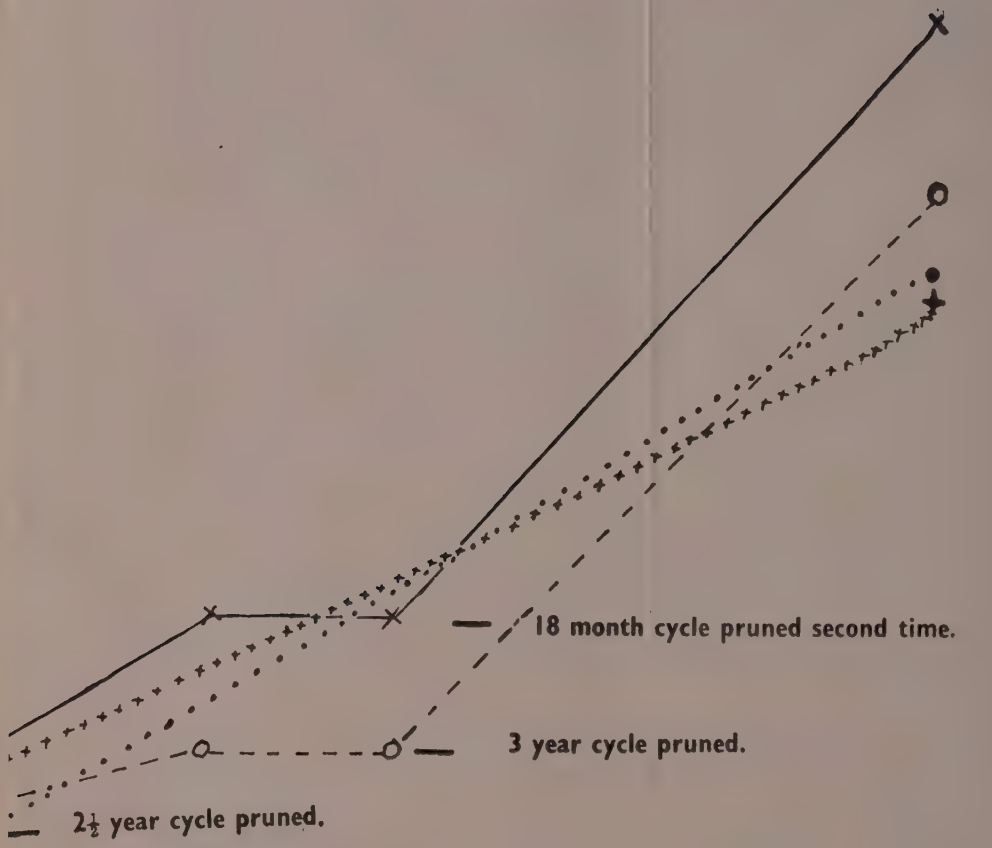


Fig 1. Yield graph of the Nyiriva experiment. No



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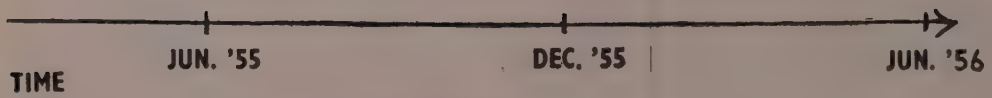

te consistent lead maintained by the 18 month cycle.

failure'; further enquiries, however, revealed that this conclusion was reached as a result of combining an 18 month cycle with the clean prune then in vogue, and moreover that the pruning height was about 12 inches and even less! True the number of beetles may well have been greatly reduced by this drastic method, but my impression is that most planters are concerned more with increasing yields than reducing borer population! In fact, it is a matter of considerable surprise to me that any of the bushes treated in this way are still alive!

One cannot, of course, place too much reliance on such ancient records, and I would, therefore, record an incident, which has only recently taken place and which confirms my view that the success of the 18 month cycle depends almost entirely on the adoption of sound pruning technique. A field was pruned (after a period of rest) on an 18 month cycle in August last year, following a severe attack of shot-hole borer. In the absence of the manager, a clean prune at 18 inches was given—with no rim-lungs; the consequences of this were firstly that most unusual chlorosis symptoms were observed following the second tipping, which necessitated further resting. This almost certainly resulted from the rapid new growth draining the mineral resources of the first formed shoots following recovery. That is, that the early growth acted as "lungs" for the post tipping growth. Then almost as soon as the tea recovered from the chlorosis symptoms another severe attack of shot-hole borer was experienced, necessitating yet another prune. As similar set-backs have not been observed on any estate where sound pruning methods have been adopted, the inference is apparent.

That brings me to the question of what type of pruning is the most suitable for an 18 month cycle. While again there is no direct experimental evidence on this point, observations tend to show that a light cut-across is undoubtedly the most suitable for these conditions, and this view can easily be supported on physiological grounds. It so happens that on the Ingiriya plots it was not feasible to adopt a cut-across, as this type of prune is obviously not applicable to a 3 year cycle length and uniformity of treatment was essential; the Ingiriya experiment, therefore, shows that a rim-lung prune is perfectly practicable (provided it is not lower than 18-20″), but I consider that in general a light cut-across should give even better results,—more especially of course in young tea; this can, however, only be confirmed by a separate experiment.

Another factor, which is undoubtedly of significance, is the type of plucking carried out. In this connection I would merely record that with an 18 month cycle hard plucking appears to be feasible in some places in the high rainfall areas of the low-country; on an estate where this combination has been in practice for the last 20 years or so, yields continue to be exceptionally high—yet no new wood has been put on during that period and consequently there is virtually no shot-hole borer. However, it stands to reason that hard plucking is only feasible on tea which already has well developed frames and a good cover at the start of the operation, and where adequate attention is paid to other cultural operations, particularly to adequate manuring.

Reverting again to the subject of the comparative yields of different cycle lengths, the question may well arise as to whether the experimental data which I have produced has been confirmed in practice on other estates where shot-hole borer damage is greater. While time does not permit me to go into too much detail, I would just like to quote one instance, which is of particular interest in that about half the fields on the estate are on a 2 year cycle, and the other half on an 18 month cycle. A comparison can thus be drawn between the loss in crop caused by shot-hole borer in respect of these two cycle lengths—the basis of the comparison being the yields obtained during the *dry weather months of the first and second years in the cycles*. Extracts of these yield figures are summarised in Tables 2 and 3.

Table 2. *Estate in K.V. seriously affected by shot-hole borer. Yields of fields on a 2 year cycle for January-March* 1955 *and* 1956.

Period	Year in cycle	Yields of fields in lbs. per acre
1955 January-March	1st	273 271 197 259 255 224 304 299
1956 January-March	2nd	185 164 177 162 181 184 158 151
Difference		-88 -107 -20 -97 -74 -40 -146 -148

Maximum decline in any one field during second dry weather period = 148 lbs. per acre.

Overall percentage difference = 65 per cent.

Comparative loss in crop during second dry weather period = 35 per cent.

Table 3. *Yields of fields on an* 18 *month cycle for January-March* 1955 *and* 1956 *from the same Kelani Valley estate.*

Period	Year in cycle	Yields of fields in lbs. per acre
1955 January-March	2nd	246 194 159 170 228 158 254 272
1956 January-March	1st	201 223 180 183 226 183 237 189
Difference		+45 -29 -21 -13 +2 -25 +17 -17

Maximum decline in any one field during second dry weather period = 29 lbs. per acre.

Overall percentage difference = 9.7 per cent.

Comparative loss in crop during second dry weather period = 3 per cent.

It will be seen from these extracts that in the case of the fields on a 2 year cycle, the dry weather months of 1955 happened to be the first year in the current cycle, while in the case of the fields on an 18 month cycle the same period in 1955 happened

to be in the second year (of the previous cycle). A direct comparison would, therefore, not be at all accurate, but for all practical purposes the figures speak for themselves. Note particularly that in the case of the 18 month cycle fields the greatest decline is only 29 lbs. per acre during the second dry weather period,—and in several cases there are actually *increases* recorded. I need hardly add that my advice that all fields on this estate should run an 18 month cycle has been accepted!

Although I have previously referred to an "18 month cycle" there is of course no particular significance attached to a cycle of this exact length. From the practical point of view, it will not be feasible to fit every field on an estate into an 18 month cycle, especially as this would entail periodically pruning some fields into the dry weather. However, it is quite a simple matter to get round this difficulty by varying the cycle length say between 18 and 22 months, so that fields pruned early in one cycle are pruned late in the next, and *vice versa*. A further shortening of the cycle may be considered in exceptional circumstances, though definite evidence on this question is lacking; on many estates the practice has been adopted of pruning fields as soon as a major outbreak of shot-hole borer becomes evident, the one drawback to this system being that it may necessitate pruning during the dry weather. I venture to suggest, however, that, on the basis of the data I have previously given, a major outbreak need not be anticipated once an 18 month cycle has been adopted.

In conclusion I would just add a few words on the question of the 3 year cycle in view of Gadd's and Austin's findings that a cycle of 3 years (or longer) was effective in reducing shot-hole borer incidence in Uva. As a general rule this extended cycle cannot be adopted under all conditions in the low-country,—the main condition under which it does not appear to be feasible being following a severe attack of shot-hole borer! It will be recalled that the attack of shot-hole borer on the Ingiriya plots was not regarded as a really major outbreak, and hence the yield graph of the 3 year plots does not provide a true indication of what may be expected (by way of loss of crop) following a more severe attack."

Mr. Walter's paper ends here, but I should like to say a few more words before closing this subject.

There is one possible secondary drawback to a short cycle in the low-country, and that arises from the effect of cycle length on quality. Little appears to be known about this, but I believe that Mr. Keegel intends doing considerable work, on quality and manufacture in general in the low-country on his return. It is general experience that quality improves as the cycle lengthens, but any specific information resulting from the use of short cycles would be appreciated.

OBSERVATIONS ON SHOT-HOLE BORER IN TEA SMALL HOLDINGS

R. L. Illankoon

The observations presented in this paper are those made by officers of the Tea Small Holdings Advisory Service stationed in various parts of the tea growing districts of the island and must be regarded merely as observations and not conclusions supported by data. These observations could, however, form the basis for any future experiments.

Central Province.—Central Province has the largest acreage of small holdings in tea (38,000 acres) at elevations ranging from 1,500 to 5,000 feet.

The pest can be considered serious up to 3,000 feet. Above 3,000 feet infestations are negligible and at 5,000 feet are almost non-existent. The worst affected areas are those around 2,000 feet.

The damage caused by shot-hole borer is branch breakage, resulting in loss of crop. A few cases of die-back due to shot-hole borer have also been noticed. There has been no evidence to show that the pest has been directly responsible for the death of bushes although there appears to be a certain correlation between shot-hole borer attack and wood-rot, which ultimately causes the death of the plants.

The following observations made on the behaviour of the beetle towards tea of different jats growing under different conditions at the same elevation might be of interest.

Attacks have been seen to be more pronounced in the case of mixed Assam jats than in China types with thinner stems. Well cultivated and manured fields suffer the worst damage while unhealthy, neglected bushes are rarely attacked. Infestation begins after the eighth month from pruning and reaches it peak during the second year, when branch breakage is also at its highest.

The pruning cycle at this elevation is normally two years and small holders generally prune the tea when borer attack is at its worst.

In a few cases extending the pruning cycle to three years has been found effective in minimising branch breakage during the following cycle; but this is not favoured by the majority of small holders due to various difficulties. With no manuring yields drop steeply during the third year. Also the type of plucking adopted by small holders makes it extremely difficult to run a field for three years.

It has also been observed that fields regularly cut across every 18 months suffer very little damage from borer attack. This observation has been found useful in making a practical recommendation as a means of lengthening the period between two low prunings. In other words, a high cut-across followed by a low rim-lung prune 18 months later was recommended and found effective in reducing borer damage. In this case the period between two rim-lung prunes would be 3½ years.

I would also like to give the results of a small experiment I carried out in a field which was nearly 1-1/8 acres in extent. In 1948 this field gave a yield of only

240 lbs. per acre. The bushes were completely riddled with borer damage and wood-rot. There was no prospect of reviving the bushes by improving the soil conditions. It was, therefore, decided to give the tea a "kill or cure" treatment. In 1949 when the field became due for pruning, all bad branches were completely removed and the maximum height left of any bush was ten inches. Many of the bushes had to be collar-pruned to get rid of as much wood-rot as possible.

The result of this experiment was that those bushes which recovered put out excellent frames of new wood while a few succumbed to the treatment. The number of casualties was about 7 per cent. The whole field was rested for 8 months and all vacancies supplied during the subsequent years. In 1955, six years later, this field gave a yield of 800 lbs. per acre. I do not attribute this yield entirely to the treatment given, but the fact remains that bushes so treated improved considerably and became more productive.

Sabaragamuwa Province.—The observations made by officers in the Sabaragamuwa Province, which has an acreage of over 15,000 acres in tea small holdings, are confined to Kegalle and Balangoda districts.

Kegalle district has over 5,600 acres situated at elevations ranging from 600 to 1,800 feet. It has been reported that only about 20 per cent of the holdings are affected by shot-hole borer. Generally the pest is regarded as one that does not do any appreciable damage to tea.

In the Balangoda district, with an acreage of 3,160 acres situated at elevations ranging from 1,400 to 5,500 feet, it is reported to be causing severe damage. Attacks have been found to be worst during the dry windy months. Branch breakage is also highest during this period. Strong winds accelerate branch breakage.

Uva Province.—In Uva out of a total of 7,400 acres the biggest concentration of small holdings are found in Udakinda at elevations ranging from 3,500 to 5,000 feet. The damage caused to tea in small holdings by shot-hole borer is reported to be negligible.

Southern Province.—In the Southern Province with over 14,000 acres of tea small holdings situated at elevations of 50 feet at Galle to 3,300 feet at Morawak Korale, the damage caused to tea by shot-hole borer is reported to be negligible. It is not considered a major problem nor a pest of economic importance. Only once was it reported that widespread damage was caused to tea in a new clearing.

Summary.—I would now summarise these observations as follows:—

(1) In small holdings shot-hole borer is a pest at elevations between 1,500 and 3,000 feet, almost non existent at very low and very high elevations.

(2) Well manured, healthy, high jat bushes are more susceptible to borer attack than poor bushes.

(3) Branch breakage is the chief damage, resulting in loss of crop.

(4) Breakages are heavy during the dry windy months.

(5) Lengthening the pruning cycle to 3 years has been found effective in reducing borer damage. Where this is not possible, a cut-across followed by low rim-lung pruning 18 months later, has also been found effective.

PATHOLOGICAL AND PHYSIOLOGICAL IMPLICATIONS OF SHOT-HOLE BORER INFESTATION

B. N. Webster and T. Visser

Historical Introduction.—The principal work on pathological and physiological aspects of shot-hole borer attack was conducted by Speyer, Gadd and Tubbs. The former pointed out the physiological importance of (*a*) the area of the conducting tissues of tea occluded by borer galleries—*i.e.* the wood between bark and pith which conducts water upwards (Fig. 1); (*b*) the die-back resulting from attack at nodes and destruction of buds, which was also noted by Tubbs, and, (*c*) the ultimate pathological importance of the decay of red stained areas in the vicinity of galleries. He mentioned branch breakage as of importance from its effect on loss of crop only.

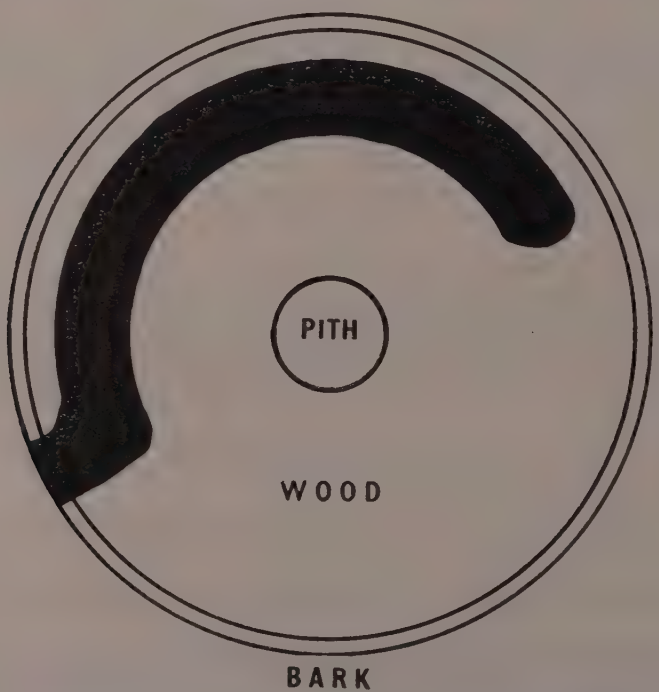

Fig. 1. Cross section through shot-hole borer gallery, showing that the gallery is found in the wood (upward conducting tissue) of the shoot.

Gadd conducted numerical surveys of the extent of die-back and wood-rot of *pruned branches* only, comparing infested and non-infested branches following pruning.

He found only minute differences, amounting to a maximum increase of about half an inch of die-back and wood-rot on infested branches, and definitely denied that much die-back or wood-rot could result from shot-hole borer attack. It must be borne in mind that Gadd's results were obtained by Mr. Austin, in Uva, and that at this time little attention had been given to shot-hole borer in the low-country.

Current Investigations.—In 1952 several estates in Sabaragamuwa were advised to extend their pruning cycles to three years, on the basis of advice given in Uva, to mitigate the effects of the severe shot-hole borer attacks which were experienced. Following a conference with Messrs. James Finlay's we were informed that this was not feasible owing to severe defoliation occurring after the second year of the cycle. This defoliation was attributed to attack by the fungus *Rhizoctonia solani* and an experiment was accordingly laid down on possible control measures of this disease. At the termination of the first cycle of this experiment no evidence of Rhizoctonia infection had been found. Nevertheless, a considerable amount of defoliation had been experienced. It was felt that the probable explanation lay in the fact that leaves, defoliated following shot-hole borer infestation, during dry weather fell to the ground, but, on the onset of monsoon conditions, horse-hair blight and thread blight held up these leaves, giving the picture said to be characteristic of Rhizoctonia.

An adjacent field on the same estate showed a considerable amount of die-back ten months after recovery from pruning. No pathogen could be found in this material, and from numerous bundles of young shoots examined it was evident that in many shoots up to 80 per cent of the total conducting tissue was occluded somewhere along its length. This conclusion was arrived at by sectioning through all galleries in a given length of shoot, and super-imposing tracings of the galleries, with the result shown in Fig. 2.

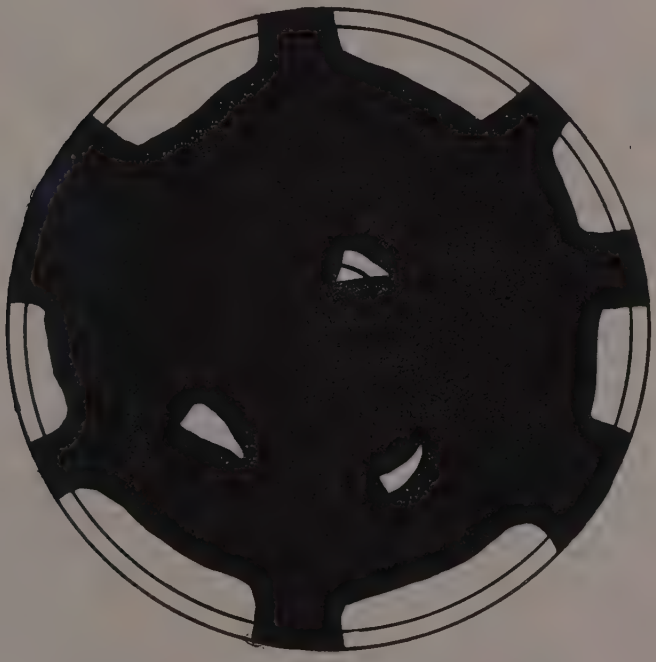

Fig. 2. The result of super-imposing sections (cf. Fig. 1) cut through all the galleries in a shoot 16″ long. Note the small amount of uninterrupted conducting tissue.

It had been postulated in the past that in a heavily galleried shoot the ascending sap stream, on being "stopped" by a gallery, would pass sideways into adjacent vessels and thus continue along a zig-zag path. Even if this were the case it must be borne in mind that the lateral rate of water conduction in woody tissues is very much slower than the vertical rate, and consequently that the amount of water reaching the top of a galleried shoot is likely to be very much less than that in an undamaged shoot.

This investigation led to the hypothesis that under extremely dry conditions the amount of water able to reach the top of heavily infested shoots was insufficient to support healthy growth, and the observed symptoms of wilt and subsequent die-back ensued.

The factor of shade must be considered here, and it has been a constant obser vation by several officers, that much of the finest tea in the low-country is to be found under extremely heavy shade.

Laboratory experiments on the uptake of water by artificially galleried shoots have been inconclusive to date, in fact many of the shoots with the largest number of galleries have shown a higher water uptake. The possibility of water loss from open gallery ends is high, and it is proposed to repeat the experiments with blocked and open galleries. However, we *did* demonstrate that very little tissue was required to support shoots, when an *adequate* water supply was available.

The possible physiological implications of the above observations can very well be applied to support the contention that a shorter pruning cycle would be of benefit under low-country conditions. As the cycle length continues, so the number of galleries per branch increases, and presumably the ability to take up water will decrease proportionately. Further the amount of maintenance foliage and consequently water requirement will *increase* as the cycle continues. If then greater water demand is coupled with reduced water availability defoliation must, of necessity, occur, particularly under drought conditions.

It is possible also that galleries in older wood, which has a greater pith area, may restrict water supply to a greater extent than in young wood, which has not developed much pith, and in which the cambium may be more active and better able to replace destroyed tissue. Thus a hypothetical explanation for the increase as the wood ages is available.

The difference between the low-country and Uva, where a three year cycle has been found feasible, must lie in the higher growth rate and increased water demand under low-country conditions. Where a three year cycle has been found possible in the low-country it has proved better than a 2 or 2½ year cycle, thus agreeing with the Uva findings, and bearing out to some extent the fact that attacks do decline in the third year, probably as a result of either a decline of the ambrosia fungus, on which the larvae feed, or the onset of physiological conditions, within the galleries, inimical to the beetle. It should also be borne in mind that hard plucking should also *minimise* transpiration, and so decrease water uptake from the soil.

Turning now to wood-rot, it can be taken for granted that the minute increase in amount of die-back, observed by Gadd to occur at the cut ends of infested branches, may be ignored. Some interesting observations by Tubbs show without doubt, however, that in pruned branches an important factor is whether a healthy bud is available or not. The known propensity of the shot-hole borer to attack at buds and nodes can result in a considerable amount of die-back. Reference to Fig. 3 explains this point diagramatically.

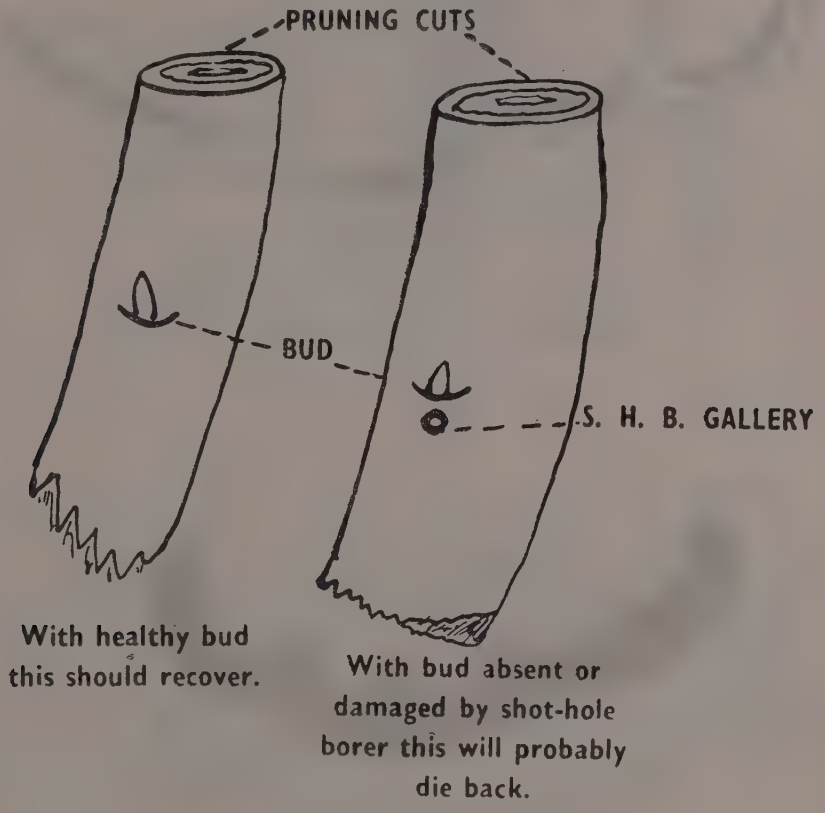
PRUNING CUTS
BUD
S. H. B. GALLERY
With healthy bud this should recover.
With bud absent or damaged by shot-hole borer this will probably die back.

Fig. 3. Two pruned branches, that on the left with a healthy bud, that on the right with a bud damaged by shot-hole borer.

The most important factor, however, would appear to be the amount of wood-rot which results from invasion through the broken off stumps of shot-hole borer branch breakage. A recent survey in an *unpruned* new clearing, which had never been cut, and on which a wood-rot experiment was proposed, gave some very interesting results.

The original experiment was aimed at keeping wood-rot *out* of new clearing tea, and included treatments to obviate entry at the "traditional" points, *i.e.* pruning cuts and sun-scorched branches. (Fig. 4).

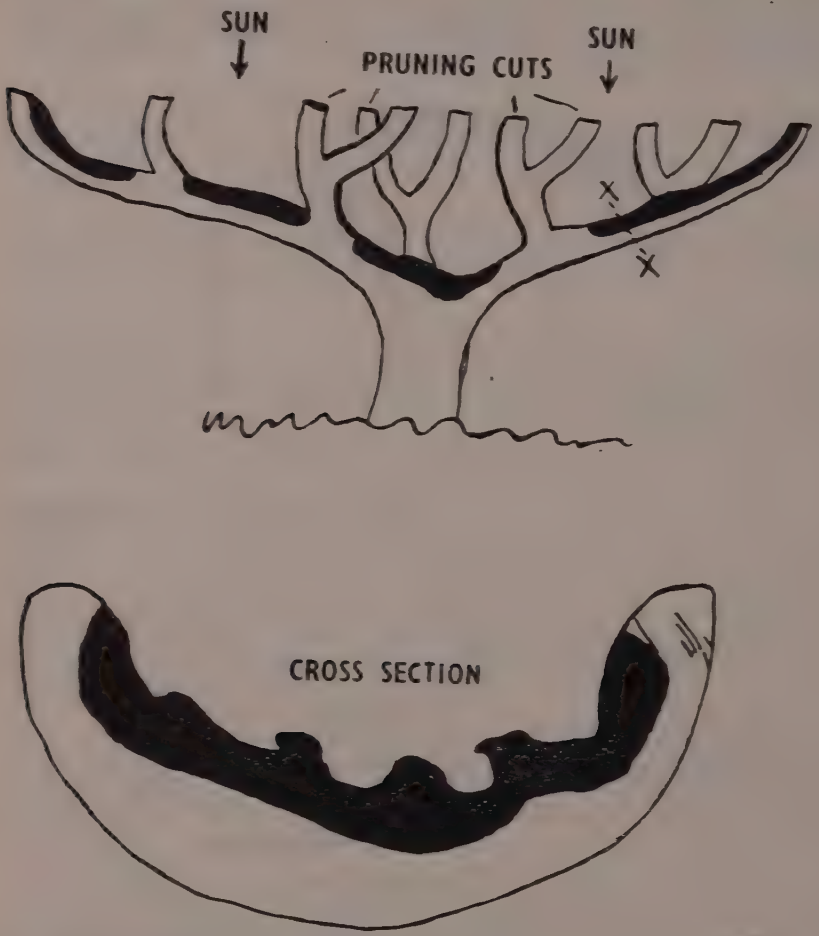

Fig. 4. Frame showing "traditional" causes of wood-rot, *i.e.* sun-scorch and pruning cuts, and cross section of badly rotted branch through X—X.

It was necessary to conduct a preliminary survey of wood-rot already present, with the following results:—

Approximately 60 per cent of the bushes were found to have wood-rot in their frames to a greater or lesser extent, and in almost every case the invasion could be traced to the point where a branch breakage had left a short snag attached to the frame. (Fig. 5). This snag had been invaded by wood-rotting organisms, which had then *continued* their growth in the healthy wood of the parent branch of the frame. An experiment is now being designed to ascertain the actual extent of such damage,

on young and old tea. The reasons for breakage are simple, viz: any cultural operation necessitating passage through the tea and undue movement in the rows. Thus the avoidance of such operations as forking, in the second year of the cycle, is to be strongly encouraged.

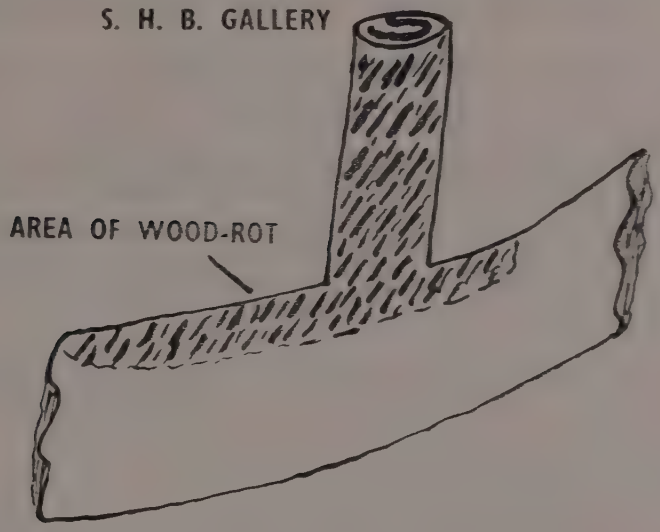

Fig. 5. Wood-rot following S.H.B. branch breakage.

It would appear likely that Speyer's observation regarding the physiological death of the stained tissues surrounding borer galleries can be accepted. That these tissues become "more acceptable" to wood rotting organisms, as suggested by Gadd, cannot be discounted, and the analysis of the staining substance would make a very interesting, and probably useful, study. Further, the possibility of the ambrosia fungus itself being mildly pathogenic is to be considered. It belongs to a natural group of fungi, many of whose members are pathogenic, and the assumption that it is "sown" on living wood, when the gallery is first opened, must bear out the fact that it is at any rate able to grow on living wood.

Further work is envisaged on the following aspects:—

1. The amount of *die-back* resulting from (*a*) total galleries in a given shoot and (*b*) galleries made at, or in the vicinity of nodes.

2. The amount of *wood-rot* resulting from (*a*) broken branch snag infection, (*b*) the death of stained tissues in the vicinity of galleries and (*c*) wood-rot resulting from the continued growth (if this is shown to occur) of the ambrosia fungus.

3. The effect of shade on the degree of die-back under drought conditions.

4. The possibility of controlling the ambrosia fungus with new systemic fungicides, and thus controlling the beetle by depriving it of its food supplies.

MANURING OF TEA AND POSSIBLE CONNECTIONS WITH SHOT-HOLE BORER ATTACK

J. A. H. Tolhurst

Let us be quite clear at the outset that my contribution to this symposium is an indirect one, and that the aim of our agricultural chemical research is to obtain and to maintain the best possible state of nutrition for the soil and the tea bush. I do not believe that manure can cure an attack of any pest or disease, but I do believe that the methods of prevention and control can be assisted greatly by a proper state of nutrition of the plant, and may be just as surely negatived if the plant is already weakened by a struggle to obtain the right kind of diet.

I intend to tell you why I am of the opinion that there is a nutritional upset already evident in a lot of tea in the mid and low country, and how my programme of research into that problem may help my colleagues in tackling shot-hole borer. First of all I must summarise the past work which has been done on relations between manuring and shot-hole attack.

This has concentrated on the possibility of building up the branch strength and thickness mainly by means of increased potash manuring. In several instances this has been achieved, and the bush has appeared to withstand the damages of the borer.

Examinations by my colleagues in past years, have, however, shown that where the wood has been improved in such a way, the actual number of galleries per bush has often increased. A change in the nutrition of the bush has allowed it to gain the initiative over the pest. How long this favourable balance would persist we can not say, nor can we say how the pest would be able to adapt itself to the new environment, and perhaps renew the attack with increased vigour.

Increased potash has not always improved the growth of wood, and the main reason for this is undoubtedly to be found in the fact that under certain soil conditions only a proportion of an application of manure may ever become available to plant roots, the remainder being chemically fixed by the soil. I am not going into details on this point, but this question of availability of nutrients in the soil is of great importance in considering the next aspect of nutrition.

All over the lower elevations the tea tends to show a definite chlorotic pattern on the leaves, and this is more pronounced in some districts than in others, and worse in dry seasons than in wet ones. Planters are familiar with this yellowing, and the usual reaction has been to describe it as one of the symptoms of shoot-hole borer attack. I am not prepared to accept such a simple explanation.

Even in the course of brief tours I have seen severe chlorosis with no trace of shot-hole borer in the bushes, and I have also seen bushes riddled with galleries but with none of this yellowing on the leaves. It is true that the chlorosis and the effects of the borer are both worse in dry, sunny, periods; it is true that both tend to become worse as the tea ages from pruning; but all this is not sufficient to over-ride the fact

that the chlorosis can occur independently of the borer. It is highly probable that where both occur in the same bush each accentuates the harmful effect of the other. It is quite certain that a leaf which is more yellow than green, as often happens, is not pulling its weight in food production, and that the whole of the bush must suffer as a result. Any further interruption in the physiology of an already weakened bush would be expected to have a more severe effect than if the bush had been healthy in the first place.

Unfortunately the sorting out of this type of problem can not be settled in a few weeks. I have already mentioned the effect of pruning and season on the chlorosis, which involve the matter of shade, and there would have to be a more precise examination of the direct relation between the borer and the chlorosis. Before any of this could be settled we should have to know what caused the chlorosis itself, and how to cure it, and this promises to be a tricky problem.

I can not say much more than I did at the 1955 Conference, except that a few chemical analyses have strengthened my idea that we are dealing with some of the trace elements, and that soil pH and organic matter are going to be intimately connected. Over the last eighteen months we have done a few thousand pH and organic matter analyses and we can begin to see a connection between the organic matter and elevation which seems to support my theories on trace elements in relation to this chlorosis. The next step will be a field survey of the chlorosis, with leaf and soil samples for chemical analysis.

I am not going to take up any more of your time with speculation on the future, but you may be interested to hear of a field experiment which I started a year ago on Sapumalkande Estate, Dehiowita, with the enthusiastic co-operation of Mr. Whitfield.

The tea was then seven years old, from seed on old rubber land, the jat being very uniform. Plucking is to the fish leaf and the pruning cycle eighteen months. Estate manuring is at a rate of 10 lbs. nitrogen to 100 lbs. made tea, using T.175 manure thrice annually, with no cultivation. Shade, with gliricidias only, is very uniform and moderately heavy. The experimental plots, twenty four in number and one fortieth acre each, lie on an almost level area.

The soil pH was very low, and some plots were treated with lime, calcium hydroxide, to raise the pH; other plots had equal dressings of calcium in a form which did not affect the soil pH; other plots were left as they were. In each of these three groups four plots had the normal estate potash manuring and four had extra potash, the whole being arranged in one of the recognised patterns for field experiments.

Thus there are several important points which are covered by this experiment, but the most interesting one to mention now is that this tea had only slight evidence of the chlorosis and no sign of shot-hole borer when the experiment started. There is a trace of borer appearing now, and it will be interesting to compare the increase in the borer in the different plots with any change in the chlorosis. There is also the obvious comparison with the Endane manurial experiment where the borer attack was severe before the manurial treatments began. The Endane experiment also contains various ratios of potash, but here the plucking is to the full leaf, which will give us yet another interesting comparison with the Sapumalkande experiment. Neither of these experiments can be wholly interpreted without chemical analyses, and, of course, chemical analyses would be of little use without such field experiments.

I think we have already got a very good foundation for studying the connection between shot-hole borer attack and several different aspects of manuring and soil conditions, and even if the entomologists decide they can cope with the pest on their

own, as I hope they can, the work which I have outlined will still have its own value. I must end with a word of warning. Field surveys followed by laboratory examinations take a considerable time, and no one manurial problem can be considered as a thing apart, since all aspects of plant nutrition are linked together in one way or another. While this will mean that we shall accumulate a lot of inter-related information, a useful process in itself, it must also mean that we must go carefully before making too definite pronouncements.

Mr. Portsmouth.—Mr. Tolhurst's paper concludes the contributions to this symposium which are being made by the scientific officers of the Tea Research Institute, but before we go on to the planting contributions I think this will be an appropriate time to ask Mr. Ananda Rau of South India to tell us a little about the pest in South India. I therefore call upon Mr. Ananda Rau, who is the entomologist of the United Planters' Association of Southern India.

ADDRESS BY MR. S. ANANDA RAU, ENTOMOLOGIST, UNITED PLANTERS' ASSOCIATION OF SOUTHERN INDIA

Shot-hole borer is not the same serious problem with us in South India as it is with you in Ceylon. We have not paid any great attention to this pest and very little investigation has actually been done. I am not, therefore, in a position to make any material contribution to this problem. Nevertheless, it may interest you to know that this insect does occur on tea in South India and I shall make a few observations on its incidence as far as it concerns us.

The occurrence of shot-hole borer in South India was in considerable doubt for a long time and it was not until 1935 that we were able to establish with any degree of certainty that the insect found occasionally in our tea was the true shot-hole borer. In 1914, Fletcher, on the authority of Anstead, stated that this insect occurs in tea in two districts, but in 1918 Speyer, writing about the distribution of the pest, consulted both the North East Indian and South Indian authorities and came to the conclusion that "the authorities in India have recorded this insect in that country on the slenderest ground and the fact that no specimens of *Xyleborus fornicatus* are available from India for identification, except in one authentic case from Bangalore in castor-oil tree, gives legitimate cause for assuming that the insect does not exist in tea either in India or Assam". Subsequently, however, Beeson in 1926 pointed out that the above statement by Speyer was erroneous and in support of this contention published a record of all the localities in India from which *Xyleborus fornicatus* was collected. This included Bengal and United Provinces in North India and several localities in the Nilgiris in the south. In none of these localities, however, was it found on tea, and Beeson in his publication of 1930 stated that "there is no authentic record of the species from tea in South India, the Dehra Dun district or Assam and Bengal, although it actually occurs in some tea growing areas."

To the South India tea planter, this might have been a very reassuring statement, especially after those made by Anstead and Fletcher, but later identifications, made by the Commonwealth Institute of Entomology and Dr. Beeson himself of materials sent to them by us, have left no doubt whatever that the insect actually occurs in tea in South India. In the light of this evidence, it may legitimately be assumed that Anstead and Fletcher were not wrong and that the insect was present in tea even before 1914.

Having established the fact that shot-hole borer does occur in tea in South India, we watched the situation during the next few years and collected a series of beetles at different times. This series was examined by Dr. Beeson and his examination revealed that the majority of the beetles showed a mixture of features of *fornicatus* and *fornicatior*. The typical *fornicatus* features were possessed by a small number of individuals while the number of individuals conforming to the fornicatior type was equally small. This examination also brought out the fact that the insect, even after several year's breeding in tea, had not produced a race which was exclusively *fornicatior*, although continuous breeding in tea does produce modifications tending in that direction. Dr. Beeson was of the view that the condition of the tea bush, the climate, etc. are probably more influential in Ceylon than they are in South India and that there was little danger of introducing and establishing a particularly 'virulent' race from Ceylon.

As far as our observations go, the areas of distribution of this pest are still very restricted. They are confined mostly to one district, but even there the insect has shown no marked tendency to spread. Although we used to receive from this district occasional reports of damage in earlier years, we have, strangely enough, received no reports since 1946. While this is by no means suggestive of the disappearance of the insect from our tea, it is not improbable that our present cultivation methods, pruning and more generous manuring than in the past have helped to reduce the pest to one of even lesser prominence than before.

This is our position today. The question of how best to control the pest or prevent its spread has not arisen with us, but we are watching with great interest for any developments in control methods which may result from your investigations.

Mr. Portsmouth.—Thank you very much Mr. Ananda Rau for your contribution which is one which I propose to commend for serious consideration to our officers and others working on this problem. South India should obviously congratulate itself on a very lucky escape and when Mr. Ananda Rau returns to India he will also, I am sure, be convinced how extremely lucky they are in not having this pest as badly as we have it here. General climatic conditions in South India and the present methods of growing tea are not very different from what they are in this country, and there must be some very small climatic or other difference which keeps this pest down. It would be a matter of considerable interest if we can find out what that difference is and investigate it. It is a point well worth looking into.

Now we will come on to what is the main point of this symposium, and that is the suggestions and reports, which are being put in both collectively and individually by members of the various Planters' Associations. In view of the fact that this symposium owes its origin and its organisation to the Sabaragamuwa Planters' Association, I think it would be only right for me to ask their Chairman today to give us the views of his Association, and I therefore call upon Mr. Cowling to give us his contribution.

VIEWS OF THE SABARAGAMUWA PLANTERS' ASSOCIATION

D. L. Cowling

It was in 1951 that very grave concern was shown with regard to shot-hole borer infestation in certain areas of Sabaragamuwa. In early 1952, the Tea Research Institute started a series of experiments in the district, mainly with insecticides, using both liquid sprays and dusts, in an attempt to control the pest.

The upshot of these experiments was that they showed, as had been expected, that the application of insecticides if used in sufficient concentration resulted in the appearance of other pests detrimental to the tea plant and, in consequence, these experiments had eventually to be discontinued.

During the course of the year 1954 shot-hole borer infestation became so serious generally that it was feared that new planting might have to be suspended. It was particularly noted that the heaviest incidence of the pest was occurring in second year fields of mature tea, which were on a two year pruning cycle, and in young clearings. In this district alone some 7,800 acres of young tea clearings have been planted since 1946.

The planters of Sabaragamuwa are indeed indebted to Mr. G. B. Portsmouth, our present Director, for the very great efforts which he made at this time, and for the interest which he took, which has resulted in the appointment of a full time officer of the Institute to investigate the problem.

Coming now to the question of crop losses in this district, it has been found that actual losses of crop in young clearings in bearing have been as high as 500 to 700 lbs. per acre per year. Similarly, in old mature tea areas, losses of from 150 to 200 lbs. per acre per year are commonly experienced due to the ravages of the pest. In addition to the very serious losses in crop, shot-hole borer also causes permanent damage to the frames of the bushes. The damage caused in this fashion is incalculable and, since it is cumulative, an estate suffering heavy shot-hole borer infestation will, in the course of time, experience a serious depreciation in the capital value of its property.

The following observations in regard to this pest have been made in this district during the past few years and it is hoped that these views will be of some use to those who are concerned with the investigation of this problem:—

(1) It has been found that damage by way of broken branches seldom occurs until some 18 months after pruning. Thereafter the extent of the damage caused by branch breakage steadily increases until the 24th month. Observations have not been made after the 24th month since most estates in this district are pruning on a two year cycle.

(2) It has been noticed that the more healthy and vigorous bushes often appear to be more prone to attack than the less healthy bushes. Similarly it appears most definitely that high jat tea is liable to sustain more severe damage than poor jat varieties.

(3) In certain cases, where a bush has suffered a very severe attack from ground level, it will die off, but will subsequently grow completely new wood from ground level and once again become vigorous and healthy.

(4) When tea has been severely attacked, naturally the health of the bushes deteriorates more rapidly, making it essential for a much lighter system of plucking to be adopted.

(5) The spread of the pest appears to be fairly slow, but is at the same time steadily progressive. This was clearly demonstrated on an estate in this district, in which a new clearing, adjacent to an old tea area, was found to contain the beetle some 500 yards from the old tea boundary, in its fourth year after planting. On the same estate an isolated tea clearing, four years after planting, was found to be almost completely free from shot-hole borer attack.

(6) Where a bush is showing signs of extensive yellowing of the leaves, shot-hole borer is invariably found to be present.

(7) There is a tendency on some estates in this district to resort to an 18 month pruning cycle as a measure against shot-hole borer. Whilst this may be an effective method of considerably reducing shot-hole borer infestation, it is open to grave doubt as to whether an 18 month cycle of pruning could be sustained as a long term policy.

(8) In the low-country the callousing over of shot-hole borer galleries does not occur.

All the above observations have been made by various planters in this district from time to time, and it is hoped that they may be of some value to the scientific officers who are at present grappling with this problem and who we have every confidence will meet with eventual success.

Mr. Portsmouth.—Thank you very much Mr. Cowling. We have also had contributions from the Kandy and Nuwara Eliya Planters' Associations, and I now call upon Mr. Gordon Pyper to talk on Kandy's contribution to this conference.

VIEWS OF THE KANDY PLANTERS' ASSOCIATION

G. Pyper

Incidence.—Shot-hole borer has always been present in most areas around Matale, Kandy, Hanguranketa, and would seem to be confined in Madulkelle district to an altitude up to 3,500 feet, and to go as high as 5,000 feet in Hanguranketa. However, there is little evidence of damage or loss of frame at these higher altitudes although galleries can be seen. There is no evidence of any recent invasions into tea not previously attacked, but it is the general opinion that the pest is spreading all the time.

Damage and Other Complications.—Severity of "break-back" damage to branches and frames of bushes is generally worst at the lower altitudes up to 3,000 feet, and is certainly very severe during periods of dry weather or drought. It has been observed that attacks tend to increase after a short spell of rain falling during an extended drought, which may be due to the rise of sap in the branches attracting the beetle. In more windy areas incidence of attack seems to be rather less general than in parts which are sheltered. Damage has been observed to vary with the jat of bush. High, quick-growing, long-legged types are definitely worse sufferers than slower growing lower jats.

The higher the elevation and the jat, the higher the level of the galleries in the branches, while at lower altitudes with poor jat the galleries are much lower down and even in the stumps below ground level.

Single bushes are often more susceptible than others and no one has produced any evidence of a shot-hole borer resistant bush being found. Attacks are worse in the new succulent wood above the pruning cut than in older branches.

An extended pruning cycle and higher manuring has proved extremely beneficial, keeping bushes healthier and encouraging growth of new wood and bark and rapid healing of galleries.

Spacing of Bushes.—Greater damage from break-back occurs when bushes are planted 4 ft. × 4 ft. than when planted 3 ft. × 3 ft. although the incidence of the borer is just the same. With the closer spacing branches are self-supporting when there is movement through the rows: consequently there is less breakage and galleries or half breaks are able to heal.

Die-back.—Dry weather pruning where shot-hole borer is present causes severe die-back and many deaths. The sap seems to sink and takes months to rise again. In gravelly areas particularly, recovery after dry weather pruning is slower than recovery from blister blight, especially with high jat bushes; casualties are also far higher than from blister blight.

Chlorosis.—It is the unanimous opinion that chlorosis is definitely connected with shot-hole borer. Discolouration seems to start around 12 months—24 months from pruning, varying in different elevations and districts, and getting worse at the end of the cycle. Besides discolouration and leaf-fall, buds get smaller and fail to break at all, and the bushes appear scraggy and thin; this condition appears in both good and gravelly soils especially during spells of hot, dry weather.

Thatching of the soil with mana grass has definitely proved beneficial and reduces the incidence of chlorosis.

It has also been observed on Hanguranketa estate that, where shade has been established in previously bare and exposed tea, the incidence of shot-hole borer appears to be less, but on other estates with good high shade, this has had no apparent effect, shot-hole borer being the same from year to year, but less evident in wet years than in dry ones.

Abandoned Tea—Jungle Areas.—Tea, which has been abandoned for many years and isolated, has been observed to be comparatively free from galleries, presumably because the wood is more mature and less palatable.

In one area planted in jungle in 1900, the tea bushes, though never growing very large, are riddled with galleries, but break-back damage is not apparent.

Shot-hole borer attacks Albizzia, Grevillea, Crotalaria and in jungle areas Lantana and other soft wooded bush trees, causing quite severe damage to the first two types of trees when they are young plants.

Loss of Crop.—Estimates of loss of crop in mature tea vary considerably; assessment is difficult, but all agree that shot-hole borer definitely causes loss of crop, with anything between 100-250 lbs. per acre per year as the general view, though some would definitely go higher than this at 300 lbs. per acre.

New Clearings.—Borer damage, as evinced by broken and cut off branches, starts from as early as 12 months to 2 years from planting, provided the growth of the plant is sufficient and the wood suitable for borer attack. Galleries are from ground level upwards. Very often the main stem breaks at ground level or one inch above. After the first prune from 3 years onwards damage is far less evident.

It is in this first stage up to the first prune that loss of crop is severe, entirely due to the bushes having to replace their frames instead of growing flushing points. One-third or more of the bush may have to be restored at any one time.

Damage is as heavy in new fields, in spite of far less disturbance by pluckers, etc., as in older fields. Conditions would seem to be more suitable to shot-hole borer on account of soft tender wood and the stems being nearer the ground. All bushes, whatever the jat, are attacked when they reach the attractive stage of growth: in some instances, when conditions are suitable for rapid growth, this may be within 12 months of planting.

Losses at this stage up to the 6th year from planting of a new clearing may easily be 300 lbs. per acre. New tea bordering old is sooner or later attacked by shot-hole borer, but in Madulkelle there is a new clearing of 23 acres, bordering an old field, which was planted in 1947 and is now 13 months from last prune, and which so far shows no visible sign of any shot-hole borer attack; yet the old field of 23 acres, roughly the same time from pruning, is riddled with the borer, and is at present going through such a severe attack that its yield last month was only 5 lbs. per acre. The bushes are thin, scraggy and full of chlorosis as well as being severely damaged by break-back.

General.—Since shot-hole borer causes so much damage to both young and old tea, which would otherwise be giving higher yields, all are agreed that ways and means should be found first to protect new tea up to the age of 6 years, when it becomes mature and established, before trying to protect old fields with the present means of control at our disposal today. Shot-hole borer is Public Enemy No. 1 of tea—eradicate or control it, and you unlock the door to higher yields on mid-country estates with what might well be spectacular increases.

Mr. Portsmouth.—Thank you very much, indeed, Mr. Pyper, for your most valuable contribution. The Nuwara Eliya Districts Planters' Assoication has also sent in a contribution, which I will now ask Mr. C. A. Wilson to read to you.

VIEWS OF THE NUWARA ELIYA DISTRICT PLANTERS' ASSOCIATION

C. A. Wilson

Generally speaking 90 per cent of this planting district is not at present affected by shot-hole borer; in fact Maha Uva Estate must be one of the few, unless possibly lower Udapussellawa towards the Welimada short-cut is also affected.

Before the war shot-hole borer was considered quite serious on this estate, but affected areas were manured more liberally at a rate of 57 lbs. nitrogen, 24.75 lbs. phosphoric acid and 19.69 lbs. potash per acre as opposed to the general dose of 51 lbs., 22 lbs., and 17.50 lbs. per acre respectively; this, together with extension of pruning cycles to 3 years, was the method of combating the disease.

When I returned to Maha Uva in 1954, I did not at first agree with the Tea Research Institute that shot-hole borer had increased recently; the number of odd dead branches broken off at joints seemed to me to be less than previously and fewer than in the Kotmale districts, where I was planting in 1946.

However, as soon as I started pruning some lower fields in 1955, I realised that it was very true indeed that the insect had increased enormously and was now a very real menace.

I have tried spraying, as recommended, an experimental one acre of 1955 and one acre of 1956 pruned fields with Dieldrex, but do not expect to notice any difference until next pruning in 1960 and 1961; at present there is no noticeable difference in the foliage of the 1955 acre.

At present crops continue to increase (including shot-hole borer infested fields) so that one cannot say that there is any loss in crop. However, I consider that the effect of the damage is cumulative, and a very serious potential danger. At each pruning more and more branches are affected and one can trace the different stages on the pruned branches (*a*) pellet like marks (*b*) beginning of rotting (*c*) definite holes (partly of course, wood-rot following the attack). The wonderful recovery which the bush is able to make after pruning in re-affoliation and resumption of its normal canopy of foliage is amazing; thereafter one sleeps better and ignorance is bliss until the next pruning. As stated before the effect is cumulative and large areas may require replanting simultaneously if the damage goes too far and the bush has no longer the vitality to recover from pruning. This position is rendered more serious still if it is true that, in a young clearing in the low-country, shot-hole borer has attacked the plants which are just about to come into bearing.

Shot-hole borer seems to take a much heavier toll during the drought and recently many more dead and dying branches than usual have been in evidence.

Tea infested by shot-hole borer has been found on this estate up to an elevation of approximately 4,500 feet.

Mr. Portsmouth.—Thank you, Mr. Wilson, for your very valuable contribution. You have drawn attention to one important point, and that is the cumulative effects of the damage caused by the borer, resulting in considerable loss of capital value in

the shape of deteriorating bushes. This has to be added to the annual loss of crop, to which so far most reference has been made. I think you are probably quite right in the fact that the borer seems to be spreading in districts at high elevations; there is quite a lot of shot-hole borer in some estates in the Talawakelle district, which are all over 4,000 feet. Well, gentlemen, that concludes the reports and suggestions of which I have had notice, and I accordingly now place the whole subject open to general discussion.

DISCUSSION

Mr. Whitfield.—Mr. Walter is not here, but I would like to express my appreciation of the paper he has submitted. May we hear of the merits of a 2 year pruning cycle with light plucking, as against an 18 months pruning cycle with hard plucking?

Mr. Portsmouth.—I have been asked a question on plucking. I do not quite know how at this stage we can answer that question. I am certainly not prepared to make any recommendation, but I will say that, as has been mentioned by some of the previous speakers, it would seem that it is quite feasible to hard pluck under general mid and low country conditions with two particular precautions, the first of which is that you must develop an adequate amount of maintenance foliage, at the very beginning of the cycle, following recovery from pruning, and, secondly, that you must give adequate manure. I do not know whether Dr. Visser would like to comment on that at all.

Dr. Visser.—A point in favour of hard plucking is that, in reducing the maintenance foliage, it is likely to decrease the water requirements of the bush to a greater extent than light plucking would do. That is to say, branches whose water uptake is impeded by the presence of shot-hole borer galleries will be better able to bear the strain of increased transpiration, due *e.g.* to drought conditions, if their leaf number has been reduced by hard plucking.

Extension of the cycle to two years will undoubtedly increase the number of galleries, which may lead to an increase in branch breakage and lessen resistance to adverse weather conditions.

Mr. Webster.—The results of the Ingiriya experiment have shown that an 18 months cycle has given greater yields than other cycle lengths. These results were achieved with light to moderate plucking. So if an 18 months cycle with moderate plucking is better than a 2 year cycle with the same plucking it seems reasonable to suppose that an 18 months cycle with hard plucking might give even better yields.

Mr. C. R. Warren.—The lack of carbohydrates in low-country tea has always been our greatest problem. Now this short pruning cycle is nothing new in the drier districts. Many of us have been on a short cycle, with a cut-across prune, for well over 25 years and in some cases yields have been over 1,000 lbs. per acre throughout. But although hard plucking and an 18 months pruning cycle may give us a temporary solution or a temporary boost of crop, I am rather reluctant to look upon it as a long term policy in view of the lack of carbohydrates. I agree that it might be a short term solution where the tea has been badly affected.

Mr. Portsmouth.—Thank you, Mr. Warren. I am glad you raised that point. I do not quite know what this effect of frequent pruning is going to be. It certainly seems rather doubtful as to whether we can combine both hard plucking and frequent pruning without getting, possibly, poorer and poorer recovery in succeeding cycles. As yet we do not know enough about any of the long term effects of the suggestions which have been put forward today, and none of them should necessarily be regarded as having the force of official recommendations. They are merely suggestions for investigation. I do not want anybody to go away and say that, because somebody has found good results from an 18 months cycle, everybody else is going to get equally good results after they come to the 6th or 7th cycle.

Mr. Watt then quoted figures from Endane Estate to indicate the loss of crop being caused by shot-hole borer. These figures are tabulated below.

Table 1. *Endane Estate. Yields and loss of crop in fields on a 2 year cycle, pruned in* 1954.

Age from pruning	Average monthly yields lbs/acre	Monthly loss of crop lbs/acre	Total loss of crop lbs/acre
4–18 months	135	—	—
19–22 months	118	17	68
22–24 months	87	48	96

The total loss of crop during the last 6 months of the cycle is seen to be no less than 164 lbs. per acre. Mr. Watt went on to say that the loss of crop did not stop after pruning. On 189 acres at Endane, which was changed from a 2 year pruning cycle to an 18 months pruning cycle in 1955, the yield for the first 10 or 11 months of the current cycle was 1,134 lbs. per acre compared with 951 lbs. per acre in the previous cycle, an increase in the 18 months pruning cycle of 183 lbs. per acre or 19¼ per cent. There was no question but that the loss of crop during the last six months and the falling off of crop during the first 10/11 months of the 2 year cycle was entirely due to shot-hole borer. The sum of the two losses was 347 lbs. per acre over 17 months, or approximately 242 lbs. per acre over an year.

Mr. C. V. Warren asked whether there was anywhere in Ceylon or other tea producing country where shot-hole borer had actually killed out any appreciable acreage or alternatively where any appreciable acreage had ceased to economically yield because of shot-hole borer.

Dr. Judenko was unable to answer this question. He explained that the distribution of the insect and its probable seriousness were likely to be influenced by environmental and biological factors and by farming practices, and experiments to find out why the pest was important in one place and not in another had not yet been carried out.

Mr. Gordon Pyper remarked that most planters only noticed the incidence of shot-hole borer by the damage done through break back of branches. It was very difficult for them to assess the degree of infestation or to say whether the population of the beetle was increasing. He asked Dr. Judenko to explain his technique for measuring the severity of attack and to make it simple enough for general use by superintendents.

Mr. Portsmouth emphasised the importance of obtaining objective assessments of the degree of damage and suggested to Dr. Judenko that, if possible, he should consider developing his method of standard assessment in a simple form such as could be applied on estates by superintendents.

Dr. Judenko said that he had carried out assessments of five fields, and intended to do 20-50 more. He hoped to find a simple method. It appeared from the results of the five tests so far that, when the number of galleries was less than 50, damage done by the pest was negligible, but, when the number of galleries was more than 100, superintendents complained of damage. This was the only indication at the moment; more assessments would be made and an answer might be available in 2-3 months.

Mr. Portsmouth though that the method of assessment already developed could be carried out by the different officers of the Tea Research Institute, and assessments would be made on various Tea Research Institute field experiments.

When an officer visited an estate it would be quite possible for him to make, without a great deal of trouble, a fairly straightforward assessment of the degree of damage. The Institute had only just started to go into this question of standard assessment, and it might be a little while longer before a really useful workable form was finalised.

Mr. Cowling put forward the following questions from a planter in Sabaragamuwa.

(1) Is the ambrosia fungus existing in symbiotic relationship with the shot-hole borer or is it parasitic on the tea bush?

(2) On what is based the assumption that the population of shot-hole borer has increased during the last 3 years?

(3) Can Dr. Judenko's findings on the severity of infestations be correlated to the type of pruning done on estates where he has made his observations?

(4) In a small district could this pest be highly localised in any one property?

(5) Could it not be possible that there has been no serious increase in the pest during recent times, but that an apparent increase has been due to the large losses in crop experienced in old tea from other causes?

(6) Could not the apparent gravity of the pest be due to the cumulative effect of old galleries under the system of continued light pruning?

Mr. Webster, replying to the first question, thought that there was no evidence of symbiosis at all. The fungus appeared within a few days of the galleries being bored by the female beetle. No doubt the spores were transferred from the old gallery which the female had vacated to the new one, but whether consciously or unconsciously was not known. There was no doubt that the fungus was able to exist on the relatively fresh wood on the inside of the gallery, which suggested that it was mildly pathogenic on the tea bush and was able to live on the living wood; the sections through the galleries indicated that the mycelium of the fungus spread anything up to $\frac{1}{4}$ to $\frac{1}{2}$ inches away from the gallery within the cells of the wood.

Dr. Judenko said that, from the entomological point of view, the relationship between the beetles and the ambrosia fungus might be very important. We knew little about the subject, which still had to be investigated.

Turning to the second question, Dr. Judenko pointed out that some shot-hole borer was always present: only when the insects appeared in large numbers did entomologists refer to an outbreak. The recent general concern in the planting community suggested that more beetles were now appearing. We did not know why; temperature and humidity might be important factors, as might cultivation methods.

Dr. Judenko was unable to answer the remaining questions.

Mr. Webster said that, with regard to question 6, the cumulative effect of old galleries under the system of continued light pruning could be the cumulative effect of wood rot, and only by pruning low would it be possible to remove the rotted

tissues which had resulted from the invasion of the stained areas surrounding old galleries. Whether it was advisable in the low-country to prune low enough to cut out the whole of the wood rot, he did not know. It has been done up-country successfully.

Mr. Portsmouth called upon Mr. Frazer, who had recently adopted an interesting new pruning technique, to explain his method to the meeting.

Mr. Frazer.—The experiment which I carried out was really not directed against shot-hole borer but was in connection with lung pruning. It is now more or less routine practice, in the low-country, to leave what are termed "lungs", *i.e.* a fringe of unpruned branches, around the outer periphery of the bush, to assist the recovery from pruning. In the normal course of events, six or seven weeks after pruning, or shortly prior to tipping, these "lungs" are cut back to the level to which the bush will be tipped.

It has been my observation that quite a number of these "lungs" fail to recover, and, by dying back, create gaps, thereby reducing the original spread of the bush. In a way, the death of some of the "lungs" is not be wondered at, since in a 2 year cycle they have done their time and have probably been attacked by shot-hole borer. In some cases they even carry flowers and seed, and cannot possibly be in the condition they should be, to efficiently carry out the function for which they have been left.

The system I tried out was "lung" pruning in reverse, *i.e.* the lungs were cut back six weeks or so *before* actual pruning took place. In my experiment, I only pruned the "lungs" which abutted on to the adjoining row, and left those which were in the line. Approximately one third of the bush, *i.e.* one sixth on either side, was cut back to the level to which the bush was going to be pruned. In six weeks the pruned "lungs" threw out large numbers of new shoots, which turned out to be "lungs" in just the right condition to assist the recovery of the balance of the bush. The field was then pruned in the normal way. The new "lungs" were left untouched until the centre of the bush was ready for tipping and were then tipped with it. The result was a complete circle of new growth. In the ordinary method, after tipping has been done, the fields present, to say the least of it, an ugly appearance.

In my experiment, the "lungs" were cut back in mid-March, yet, despite the record drought conditions experienced this year, they recovered in 99 cases out of 100. They then went on to form a new outer fringe which has to be seen to be believed. If anybody is interested in seeing the results, I shall be only too pleased to show him round. Mr. Walter's comment was that it was "amazing".

Mr. Portsmouth.—Thank you very much, Mr. Frazer. I asked you to make this contribution because I do think that any suggestion which shows promise of being able to rebuild the frame is one that is well worth investigating. I do not know whether Dr. Visser has got any comments to make on this.

Dr. Visser.—I think this is an excellent idea, which should be tested further. It could indeed be expected that by reversing the lung system better results might be obtained, because it is well known that younger wood and younger leaves are more active than older wood and leaves which may have been on the bush for a year or longer.

Mr. Watt.—I do wish to bear out all that Mr. Frazer has said about this type of rim lung pruning. I have seen it and the results are really phenomenal. I think Mr. Frazer said that this had little connection with shot-hole borer but I very much disagree with that, because the tea in which this recovery has been recorded is riddled with shot-hole borer. I think this is a question to be taken up by the Tea Research Institute.

Mr. Portsmouth.—Thank you, Mr. Watt, for confirming what I felt was also worth looking into. I think I will cover it further at this stage and ask both Dr. Visser and Dr. Joachim to go into this question.

Mr. Thambipillai asked during which period in the cycle was the bush most attractive to shot-hole borer, and when did loss of crop become noticeable? Mr. Walter and also Mr. Watt had shown that good yields were maintained for the first 18 months and Mr. Austin had said that in Uva the population of borer was small in the third year of the cycle. Mr. Thambipillai also asked what were the alternate host plants of the insect.

Mr. Austin replied that the wood was most attractive at the stage of pencil thickness, some 3-4 months after pruning. From then until about the 24th month, the beetle bred freely in the bush, building up a large population, which caused noticeable loss of crop due to branch breakage. Thereafter, in Uva, it was found that the population declined, until, at the end of the third year, few occupied galleries remained. No evidence of this decline had so far been recorded in the low-country.

With reference to host plants, Mr. Austin said there were about 40 plants attacked by shot-hole borer. Speyer, who had investigated this particular point, thought that the castor oil plant was the chief alternative host of the borer; he therefore induced the Government to have every castor oil plant eradicated. However it was found later that the presence or otherwise of this plant made no difference to the amount of borer infestation. Gliricidias, Albizzias, and dadaps also harboured shot-hole borer, but only in small numbers, and, besides the castor oil plant, only *Tephrosia candida* and *Mimosa bracaatinga* had been foundt o contain large populations of the beetle.

Dr. Judenko said that, generally, young wood was attacked more than old wood. The number of open galleries was greater in young wood than in old wood. Recently tea bushes had been artificially infested and beetles had developed better in young wood than in old wood, but this did not mean that old wood was not attacked at all. At Ingiriya the influence of the pruning cycle on the appearance of shot-hole borer had not yet been considered. The number of open galleries had been counted and no difference had been found between the number of galleries on the bushes pruned at 18 months or 36 months.

Mr. Porstmouth.—There is a further point, which Dr. Judenko is now investigating, and that is the different moisture contents of the young and old wood. He has already shown that under dry conditions the beetle does not live so long, and is not nearly so active in reinfesting, and it may well be that wood which is two years old or more is less sappy or less attractive to the beetle than is young wood.

Mr. Ross remarked that shot-hole borer seemed to have come into prominence in the last two years, coinciding with a period of high prices and consequent hard plucking to obtain maximum crop. Some estates even resorted to stripping, to plucking the lungs of the bushes, and to plucking the bushes instead of tipping, in order to get leaf. Pruning had also sometimes been put off beyond the due date—anything in fact for crop. Was it possible that these practices had weakened the bushes and so made them more susceptible to shot-hole borer attack?

Mr. Portsmouth replied that it was very difficult really to get any sort of information on these questions. Evidence had been produced by Dr. Gadd and Mr. Austin that bushes receiving the highest doses of manure and all plucked equally had the highest level of borer incidence. Similarly, we had had reports from the Small Holdings Service that the borer was mainly a problem on those holdings which were in the best condition, suggesting that bushes debilitated by hard plucking were less attractive to the borer.

Mr. Austin said that Uva planters about 15 years ago had raised the same question, which was investigated at Passara. It was a popular belief that bushes plucked hard were more susceptible to shot-hole borer than bushes plucked lightly, but surprisingly, the opposite was found to be true, that bushes lightly plucked were more severely affected than those which were heavily plucked. This finding, however, had not been wholly accepted by planters.

Mr. Portsmouth remarked that there appeared to be an unfortunate agricultural conflict here. If we put the bushes in good heart by proper manuring, and treated them reasonably during plucking, we then found that they were more attractive to shot-hole borer. This just seemed to make the problem a little more difficult.

Mr. Bean.—One thing would appear to be abundantly clear from today's discussions, and that is that we do not appear to be very much nearer exterminating this beetle. We are left, therefore, with the alternative of control, and I think it is generally agreed that the main method of control is an alteration of pruning cycles; management of shade and manuring policy may assist, but this is not proved. Now the Tea Research Institute have two alternative methods of approach on this question of control by pruning. In the low-country the suggestion is a reduction to an 18 months cycle, and, apart from control of shot-hole borer, I would thoroughly endorse this from the alternative and more important aspect of crop increase. Then we have Mr. Illankoon talking of Kegalle and Kandy, and Mr. Austin talking of Uva, where a diametrically opposite view is taken, and control is sought by the lengthening of the pruning cycle to three years or possibly more. Now the reduction to 18 months could be a very considerable measure of control because you presumably prevent the beetle from building up a large population; but with an extension to 3 or 4 years those beetles will have had more time to multiply. Is this not going to make ultimate extermination of the pest more difficult?

In regard to this question of continual cutting across at 18 inches every 18 months, would not a possible solution to that be to give it one very hard rim lung prune, in say, every 4 to 5 cycles?

We are not unduly worried about shot-hole borer in the Kelani Valley, although we have some incidence. About 1948 or 1949 I treated 2 fields in this way, since when there has certainly been very little shot-hole borer incidence in those fields, which have now gone on to a 2 years and in some cases an 18 months cycle.

Mr. Portsmouth.—I think, Mr. Bean, your last remarks about pruning do again make it worthwhile to consider whether there is a possible connection between borer incidence and the totally different pruning systems adopted by North India and Ceylon. In North India there is generally a fairly light prune each year, followed at intervals of 15 years or so by what would be by our standards a very hard prune. In other words the bush is allowed to go up gradually year by year and, when it gets unmanageable, is then cut back to a fairly low level. This may possibly account for the difference in borer incidence.

The general campaign against shot-hole borer seems to clearly fall into two parts. First we can try to reduce the amount of damage by suitable adjustment of our cultural operations, such as lengths of pruning cycles, times of pruning, methods of plucking, etc. We have had put before us a very large number of quite obviously diametrically opposed practices from different areas, some of which have given good results and some of which have not. It is going to be quite impossible for us as an Institute to make any firm recommendations until we have collated and checked all this information. Then I hope we shall be able to draw up some sort of schedule of agricultural practices etc. which will help to reduce shot-hole borer damage.

The other part of the campaign is to get this insect under control by measures directed at the beetle itself. We have not got very far with this at the moment.

Mr. Watt remarked that on three estates in which he was interested potash applications had been increased above the normal proportion contained in T.500 mixture. On two of these estates soon afterwards very severe attacks of shot-hole borer had taken place; but on the third, which, in addition to the extra potash, had also been given an application of dolomite lime, shot-hole borer had not increased to any extent. In fact it appeared to have actually decreased.

Mr. Tolhurst replied that he had on one or two occasions had reason to think that the application of dolomite, possibly because of the increase of calcium and magnesium, had tended to make the bush withstand shot-hole borer attack a little better or to make it less attractive to shot-hole borer. The Sapumalkande manurial experiment, although designed as a purely chemical experiment, should help to throw some light on this problem. A number of inter-related problems, potash, calcium, magnesium, soil pH, organic matter, etc. had to be considered.

It would be of the greatest assistance if planters would keep him informed of the results of experiments carried out either by themselves or following his recommendations.

Mr. Portsmouth endorsed Mr. Tolhurst's last sentence, and appealed to superintendents, who had received advice from the Institute, or who had carried out experiments, to let the Institute know what results had been obtained from such advice or experiments.

Mr. Passingham.—I think it would be of interest to tell you of my experiences of a clean prune followed by several cuttings across in a 10 year period. This was practised for 15 years on many estates with which I am familiar between 1920 and 1935. From 1926 until 1935 shot-hole borer was a very serious menace on this programme. In 1935 a change was made to cut across pruning on a 2 year cycle, and shot-hole borer decreased. Was this merely coincidence? I fully appreciate the benefits of the 18 months pruning cycle but in your opening address you pointed out the desirability of not pruning into the dry weather. Mr. Walter's suggestion of an 18 months pruning cycle would necessitate doing that very thing. With a prune in May, June, July and August this year, the next period would be in November, December, January and February. This would interfere with crop.

Mr. Walter said it would not matter to move the cycle two months this way or that, but he did not say whether he intended eventually to lengthen the cycle back to where he started!

In the Balangoda district, where the main cropping period is March, April, May and June, if this method was carried out it would certainly tend to reduce crop rather than increase it.

I do feel that any variation on the 18 months cycle would lead to disorganisation. Mr. Walter was not a superintendent, but if any variation takes place I think it is apt to be a large variation in the pruning cycle.

Mr. Webster.—Mr. Walter's wording, in his paper, was: "A cycle of 18 months plus or minus a month or two". It was his intention to go to about 16 months or about 22 months, giving a variation of 6 months in the cycle length, together with a 6 months pruning period. I feel that tea could be pruned as he suggested, at the beginning of the pruning period for one cycle, and at the end of it for the next, but I personally agree with Mr. Passingham that the effect on organisation would be considerable.

One point has struck me since Mr. Frazer told us of his new method of pruning, which Dr. Visser said might well lead to a more rapid build up of reserves. It is that Mr. Warren's objection to continued 18 months cut across pruning can be to some extent answered, as, by building a healthier stronger bush by the use of new lungs, the fear of gradually depleting carbohydrate reserves, which are low at the best of times, may be overcome.

It was also Mr. Walter's intention to state definitely that he was of the opinion that 4 or 5 cycles of cut across prunes should be followed by a lower rim lung prune.

Mr. Thambipillai asked whether any bushes had been found, which were resistant or immune to shot-hole borer.

Mr. Austin replied that he had had some 15 clones under observation for a year. It was too early yet to say whether these particular clones would remain resistant. If anyone had a clone, which he thought was resistant, it could be included with those already under observation.

Dr. Judenko warned the assembly of the danger of making any practical recommendations from a small number of observations and experiments.

Mr. Portsmouth endorsed this warning. Tea was a very long lived crop and as a consequence the experimental work on it must take time. There was no way of hastening that process but as many basic experiments as possible would be laid down, to cover as many points as possible, simultaneously.

Mr. Whitfield remarked that Mr. Walter was possibly basing his recommendations for an 18 months cycle on what he had seen on an estate in the Kelani Valley, where a cycle of this length with hard plucking had been the practice for 28 years, and where the yield was still more than 1,300 lbs. per acre. Conditions, however, in the Kelani Valley were quite different from conditions in Ratnapura.

Mr. Portsmouth endorsed this and said that one of the difficulties in making any recommendations was that conditions not only varied from district to district and from estate to estate, but also from field to field and even within certain parts of the same field on the same estate.

Mr. Harbord.—We have heard already from Dr. Judenko that temperature and humidity may be critical factors in the life of the shot-hole borer. We have also heard from South India that under apparently similar conditions the beetle has not assumed the status of a pest. When I was over in South India this year I saw a few estates and there was one thing which did appear to be different and that was their management of shade trees. In that part of the Nilgiris which I saw there was very little high shade and no green manure trees to speak of; the general policy there seemed to be to pollard the shade trees. It seems to me possible that that gives a different shade effect and that the temperature around the tea bushes may be markedly different from what it is in Ceylon, even though the actual air temperatures are similar. I would like to ask Mr. Ananda Rau whether, in any area where the shot-hole borer has persisted, the shade is on the Ceylon pattern or on the South Indian pattern?

Mr. Ananda Rau.—The shade in South India is on both systems, depending entirely on the management policy. In some places they pollard high shade, but in others they do not. I do not suppose that I have seen more than half a dozen estates with borer attacks. It appears on estates where the shade policies are entirely different, and I have not traced any direct connection between the type and density of shade and shot-hole borer incidence. I think that other factors than temperature and moisture may be involved. We have a pest, Helopeltis, throughout one district,

at an elevation of about 3 to 4 thousand feet and under climatic conditions which one would normally expect at that elevation, whereas in another district, under apparently exactly similar conditions, the pest, though present, has shown no tendency at all to spread.

Mr. Portsmouth.—Thank you Mr. Ananda Rau. Mr. Harbord's suggestion has I think, opened up another field, on which there has practically been no investigation at all in the past, and that is the question of the microclimate around the bush. I think Dr. Judenko will probably give some attention to this in the near future. Actually, in connection with this type of work, we have purchased recently some recording meteorological equipment, soil thermometers and apparatus of that sort, which we are going to put out in different districts. We may very well have to increase the scope of that work and possibly Mr. Tolhurst might like to say a word on that.

Mr. Tolhurst.—Our knowledge of soil temperatures at various elevations and various seasons, in fact our knowledge of microclimate in general, is very limited. It has a connection with the work of all my colleagues. I am particularly interested in soil temperature from the point of view of the persistence of soil organic matter and I want to get some of these recording thermographs established on various estates. It will be a long term investigation, and records will have to be kept for some years. As far as shot-hole borer is concerned the general findings of soil temperature and humidity will have to be correlated with the general findings of Dr. Judenko on the incidence of shot-hole borer in those years.

Mr. Hodgson asked whether there was any substance in the observation, made some years before by Mr. R. G. Coombe, that shot-hole borer attacks were always severe close to areas of mana grass.

Mr. Austin replied that he had examined areas at various distances from patnas, and had not found that proximity to patna had any influence on shot-hole borer.

Mr. Austin then referred to the question of biological control of shot-hole borer. The Institute had considered this about 1938/39 and at that time had asked the advice of Dr. Beeson of the Forest Department in India, who had worked for a considerable time on the problem of shot-hole borer, not only in tea, but also in other crops. Dr. Beeson's reply had been that he thought it was a futile line of research. However, such an opinion need not necessarily be final, and since a Biological Institute had recently been established in South India perhaps Mr. Ananda Rau could say whether we would be able to submit our problems to it.

Mr. Ananda Rau replied that a small sub-station of the Commonwealth Institute of Entomology, which dealt with biological control of insect pests, had actually been set up in Bangalore. There was an American in charge of the Institute together with another officer of the Government of India. They had just started collecting information and were at present building a laboratory. The intention was to collect and correlate all the data about insect parasites in India and Pakistan, but they were not yet in a position to give any expert advice on biological control.

Mr. Portsmouth asked Mr. Ananda Rau to suggest to the Institute that they should not neglect *Xyleborus fornicatus* when they started looking for parasites of economic interest. He then asked Dr. Judenko to address the meeting with regard to the economics of control.

Dr. Judenko asked the house to assume that an effective, non tainting, non poisonous insecticide against shot-hole borer was found. That the cost of treatment with this chemical was known, and also the value of the increased yield obtained. If, for example, the cost of treatment was Rs. 100/- per acre per annum and the

increased return was Rs. 400/- per acre per annum, then the return on the investment would be 300 per cent. Dr. Judenko cited returns obtained by a number of insect control schemes in other countries, and asked what return the Ceylon planter considered would be necessary for control to be attractive financially.

Mr. Watt replied that it was most difficult to give an answer, but suggested that, from the labour point of view, it would be quite impossible for any estate to undertake anything involving more than 4 man days per acre per month; this would cost Rs. 100/- per acre per year. If the remaining costs amounted to a similar figure, the investment required would be Rs. 200/- per acre. A return of Rs. 300/- per acre, or 50 per cent, might be attractive; at Rs. 2/- per lb. the yield would have to be increased by 150 lbs. per acre.

Mr. Portsmouth said that the Institute had asked the same question at the symposium on blister blight some years before. It was necessary to have an idea how much could be managed without difficulty of labour, etc. Mr. Watt had given the planters' views; perhaps one of the Agency House representatives would like to comment on this aspect of shot-hole borer control.

Mr. De Glanville replied that it was not possible to say how much should or should not be spent on a matter so important as shot-hole borer. However, if estates now yielding say 600 or 700 lbs. per acre could get an extra 100 or 200 lbs. per acre, their cost of production would go down by anything up to 10 or 12 cents per lb. for every hundred pounds increase in crop. It would probably be worth while for such estates to spend 5 to 10 cents per lb. and get the crop up by 200 lbs. per acre. All overheads would then come down correspondingly.

Mr. Webster drew attention to the importance of protection in safeguarding the capital value of the bushes, quite apart from the actual physical gain of crop. The question of extra labour had been brought up before in connection with the control of blister blight. In the final event few estates had found it necessary to increase line accommodation.

Mr. Portsmouth agreed that the application of the blister blight control recommendations had usually proved possible with the existing labour force; the same thing would probably happen in the case of shot-hole borer if and when specific control measures could be recommended.

CLOSING REMARKS BY MR. G. B. PORTSMOUTH, DIRECTOR, TEA RESEARCH INSTITUTE OF CEYLON

We have now come to the end of what, I think, will prove to have been a very useful conference. We have heard many views and I feel sure, as I said earlier, that, when we have had time to go through the proceedings, collate ideas, and follow up suggestions, we shall find that a great deal of very useful information has come out of our efforts today. The actual assessing of these suggestions will take the officers of the Institute some time and we do not expect to be able to give you any firm recommendations in the next few months.

However, I intend to publish the full proceedings of this Symposium in the December *Tea Quarterly* in as much detail as possible. I hope that, when you have had the opportunity of going through these proceedings at leisure, some further points will occur to you and that you may be able to give us a few more helpful suggestions.

Personally I think this has been a very useful and profitable day, and I hope that everybody who has attended this symposium will go away with that same feeling. But please do not expect miracles. We will do our best and that is as far as we can go.

And now, before handing over this symposium to your Chairman, I would like to say how much I appreciate all the trouble and effort he has put into it, and how very much also we appreciate the drive shown by the Sabaragamuwa Planters' Association in getting this conference organised. I would like to assure you that we shall be only too pleased to do our best to assist all Planters' Associations throughout the country who have got useful and valuable suggestions such as this one from the Sabaragamuwa Planters' Association, to organise a conference on shot-hole borer. With that, gentlemen, I will hand you back to your Chairman, Mr. Cowling.

CLOSING REMARKS BY MR. D. L. COWLING, CHAIRMAN, SABARAGAMUWA PLANTERS' ASSOCIATION

Firstly, gentlemen, I would like to thank Mr. Portsmouth, Director of the Tea Research Institute of Ceylon, for the very kind remarks which he has just made; I can assure him that the organisation has by no means all been done by this Association. Without the valuable help of the Tea Research Institute we could not possibly have had this meeting today.

I was unable at the beginning of this conference to extend a welcome to the Chairman of the Planters' Association of Ceylon, Mr. Thomas Amarasuriya, and to the Chairman of the Board of the Tea Research Institute, Mr. Francis Amarasuriya, but I would like to do so somewhat belatedly now, and also to thank them very much indeed for taking the trouble to come up here, in particular Mr. Thomas Amarasuriya, who so ably replied to the Minister's address. I am sure you will all agree that we have had a most interesting and informative day. The facts and figures which we have heard quoted in relation to the alarming ravages of the shot-hole borer pest must have caused us all to realise more than ever the urgency with which this problem must be tackled. Mr. G. B. Portsmouth, our Director, has most ably summed up the salient points of this conference, and there is therefore no need for me to elaborate in any way. Before closing these proceedings gentlemen, I am sure you would wish me to express the deepest appreciation of the work that Professor Schedl, Senior Entomologist of the Federal Forest Reserve of Austria, and Dr. Wolf, a member of the University of Genetics of the University of Berlin, have done in conjunction with Dr. Judenko, and, with your permission, I would like to write on behalf of this conference to both these gentlemen, expressing our appreciation in suitable terms.

I would like to thank all those who have come here today and those who have contributed to these discussions. In particular I would like to thank Mr. G. B. Portsmouth, the Director, Tea Research Institute, and all his officers, for their extremely interesting observations, and for the hard work which I know they have put in in connection with this symposium.

I would also like to express my deepest appreciation to Mr. Douglas Austin for the valuable help and co-operation which he has given me during the past few weeks in connection with the organisation of this conference.

On behalf of us all here I wish to thank the President and Secretary of the Ratnapura Club for affording us the use of the facilities of this Club for this symposium. I should also like to thank in particular the ladies who produced the lunch for us today. And, of course, all those extremely willing helpers who came down from the Tea Research Institute and from the Tea Propaganda Board etc. to make this conference the success which I am sure you all think it has been.

Lastly, gentlemen, I would like to mention the most interesting definition given by the Oxford English Dictionary of the word "Symposium"—a symposium is described as a "drinking together" or a "banquet of philosophic conversation." I can only suggest that having had our "banquet of philosophic conversation," we

now proceed with the first part of the definition of "drinking together." Thank you very much gentlemen, for giving me your time and your tolerance. There is tea provided by the Tea Propaganda Board for those who do not want to get together on a "drinking together."

Mr. Gordon Pyper proposed a hearty vote of thanks to the Chairman and members of the Sabaragamuwa Planters' Association, which was passed with acclamation.

(END OF SYMPOSIUM PROCEEDINGS)

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON COLOMBO, ON FRIDAY, 7TH SEPTEMBER, 1956, AT 9-30 A.M.

Present.—Mr. F. Amarasuriya, (Chairman), Senators T. Amarasuriya, O.B.E., (Chairman, Planters' Association of Ceylon), and E. W. Kannangara, C.B.E., (Chairman, Low-Country Products Association), Mr. R. M. Macintyre, (Chairman, Agency Section, Planters' Association of Ceylon), Dr. W. R. C. Paul, (Acting Director of Agriculture), Messrs. H. S. Amerasinghe, C.C.S., (representing the Hon'ble Minister of Finance), B. Mahadeva, C.C.S. (Acting Tea Controller), R. C. Scott, C.B.E., W. H. Gourlay, J. L. D. Peiris, V. G. W. Ratnayaka, M.B.E., N. B. Parker, M. B. Butler-Cole, A. Divitotawela, W. H. W. Coultas and G. B. Portsmouth (Director and Secretary).

Also:—Messrs. G. A. D. Kehl and J. V. Harbord (T.R.I.).

A letter regretting his inability to attend was received on behalf of Mr. G. K. Newton.

The Chairman welcomed Dr. Paul, Acting Director of Agriculture, Mr. Mahadeva, Acting Tea Controller, Mr. H. S. Amerasinghe, Mr. W. H. Gourlay and Mr. M. B. Butler-Cole to the Board.

1. Notice convening the meeting was read.

2. **Minutes of the Board Meeting held on 1st June, 1956**

The minutes were confirmed, subject to the addition of the following sentence under item 8 on page 3:—"In response to a query, the Director stated that Mr. Webster was carrying out investigations on phloem necrosis".

Proposed Mr. Macintyre. Seconded Mr. Ratnayaka.

3. **Membership of the Board and Committees**

It was reported that:—

(i) Mr. S. Jinadasa, M.P., had been nominated by the Minister of Agriculture to represent the House of Representatives with effect from 30th May, 1956.

(ii) Messrs. W. H. Gourlay and M. B. Butler-Cole had been nominated by the Planters' Association, Agency Section, to act for Messrs. A. D. McLeod and G. J. Harris respectively, both of whom were on leave.

(iii) Mr. B. Mahadeva, c.c.s., Acting Tea Controller, was acting for Mr. D. C. L. Amarasinghe, c.c.s., during the latter's absence from Ceylon.

(iv) Mr. H. S. Amerasinghe, c.c.s., Acting Deputy Secretary to the Treasury, had been nominated by the Minister of Finance to act for Mr. Wickramasinghe, who was on leave from 1st September, 1956.

(v) Mr. Macintyre had become an ex-officio member of the Finance Committee on his appointment, vice Mr. McLeod as Chairman of the Planters' Association, Agency Section.

On the proposal of Mr. Macintyre, seconded by Mr. Parker, Mr. Gourlay was nominated to fill the ordinary seat vacated by Mr. Macintyre.

(vi) Arising out of the discussion on the following item it was agreed that Mr. H. S. Amerasinghe or his representative should be co-opted to the Committee of Investigation.

4. **Minutes of the Small Holdings Committee Meeting held on 1st June, 1956**

The minutes were approved, subject to the recommendation on page 2 with regard to new rates of house rent allowances being confirmed by the Committee of Investigation.

Proposed Mr. R. C. Scott. Seconded Senator T. Amarasuriya.

5. **Matters arising out of the Small Holdings Committee Meeting held on 6th September, 1956**

(i) Since the Bank had asked on what authority the Officer-in-charge operated the funds of the Service, the Small Holdings Committee submitted the following resolution to the Board:—

"That the Officer-in-charge of the Small Holdings Advisory Service of the Tea Research Institute of Ceylon, or in his absence, the Officer duly appointed by the Board to act for him, be authorised to operate on the funds of the Service, including the signing of cheques".

The resolution was approved.

Proposed Senator Kannangara. Seconded Mr. Mahadeva.

(ii) The Board took note of certain recent Press reports concerning the Institute.

6. **Minutes of the Standing Committee Meeting held on 20th July, 1956**

These minutes were formally approved.

7. **Minutes of the Standing Committee Meeting held on 10th August, 1956**

(i) **Water Supply Scheme.**—Details of the final position having been tabled, Mr. Gibbs was called into the meeting and clarified to the Board's satisfaction a number of points with regard to the dam contract. The Board then approved the sealing of the contract with Messrs. Brown & Co. at a figure of Rs. 186,659.50*.

*The contract was sealed at the Offices of Messrs. Julius and Creasy at 3 p.m. on 7th September, 1956.

Proposed Mr. Mahadeva. Seconded Mr. Macintyre.

(ii) **Addressing Machine.**—The Director reported that the addressing machine had been obtained, and the Board confirmed the Standing Committee's action.

(iii) **Visit of Professor Hardy.**—This was now not likely to be before April 1957. The Board considered that a visit by Professor Hardy would be most useful, but felt that a fortnight was too short a time. It was agreed that the Director should try to arrange for Professor Hardy to stay at least one month, with a further extension if necessary.

(iv) **Director's leave.**—The Board approved the Director's leave.

The Standing Committee's minutes were formally approved on the proposal of Mr. Ratnayaka.

8. **Minutes of the Experimental and Estate Committee Meeting held on 11th August, 1956**

The minutes were formally approved.

Proposed Mr. Scott. Seconded Senator Kannangara.

9. **Minutes of the Appointments Committee Meeting held on 24th August, 1956**

The Director read a resolution by Mr. Peiris. During the ensuing discussion Mr. Portsmouth emphasised that he agreed with the Board in taking a serious view of the present position in the low-country. In his view any valid assessment of low-country requirements demanded the full time services of a resident officer.

The Board agreed to the following resolution:—

"That Dr. Joachim should be appointed Adviser to the Board for two years (1) to submit a report within one year on the organisation of a low-country sub-station, (2) if his report is approved, to supervise the establishment of the proposed station and to train his understudy".

The minutes were formally adopted on the proposal of Mr. Parker.

On the proposal of Mr. Peiris the Director agreed to delete, for the time being, any reference to the low-country sub-station from the Institute's publications.

10. **Building Programme**

It was reported that the Architects recommended the acceptance of Messrs. Hemachandra's tender of Rs. 371,400/-, subject to minor ajudstments likely to afford some small savings. The total cost of the above Building programme was now estimated to exceed the figure approved by the Board by Rs. 72,400/-.

In addition an estimate of Rs. 30,000/- had now been given for the extensions to the Guest House and necessary furniture, making the total extra sum required Rs. 102,400/-. The Building Committee had recommended the release of this money.

The Board unanimously approved the sealing of the contract with Messrs. Hemachandra & Co. at a figure of Rs. 371,400/-, subject to minor adjustments, and also approved the release of an additional Rs. 102,400/- for the programme.

Mr. Peiris then read a report touching on various details of the building programme. The Board agreed to leave to the Building Committee decisions regarding the types of doors and windows to be fitted, and the type of finish of the houses.

11. **Finance**

(i) **Audited Accounts for 1955.**—These had been circulated to members and considered by the Finance Committee, whose comments would be fully reported in the minutes of that meeting. The points raised by the Finance Committee were then explained to members.

(1) T.R.I. Accounts and report.—The Board accepted all the recommendations of the Finance Committee except one. Subject to the remainder of the Finance Committee's recommendations, the accounts were adopted.

(2) Small Holdings Advisory Service Accounts.—The accounts were adopted, subject to the Finance Committee's recommendations.

(3) Estate Accounts.—These were adopted, also subject to the recommendations of the Finance Committee.

(4) Junior Staff Provident Fund Accounts.—These were adopted.

(5) Junior Staff Medical Fund Accounts.—These were adopted.

(ii) **Institute's Accounts to 31-7-56.**—These had also been circulated and considered by the Finance Committee. Subject to the recommendations of the Finance Committee, which were read out, these accounts were adopted.

12. **Any Other Business**

(i) Mr. Parker congratulated the Director and officers concerned on the publication of the Monograph on Tea Manufacture and the circular on drought.

(ii) On behalf of Mr. Coultas, Mr. Scott asked whether, when a planting member of the Experimental and Estate Committee was unable to attend a meeting, a substitute from that District could not be invited. This was agreed.

(iii) Again for Mr. Coultas, Mr. Scott asked that new Board members should be sent a list of the statutory dates of Board meetings. This was agreed.

There being no other business, the meeting ended at 12-30 p.m. with a vote of thanks to the Chair.

Sgd. G. B. PORTSMOUTH,
Secretary.

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Talawakelle.

Printed for the TEA RESEARCH INSTITUTE OF CEYLON, *St. Coombs, Talawakelle, by* H. W. CAVE & CO., LTD., *Fort, Colombo.*